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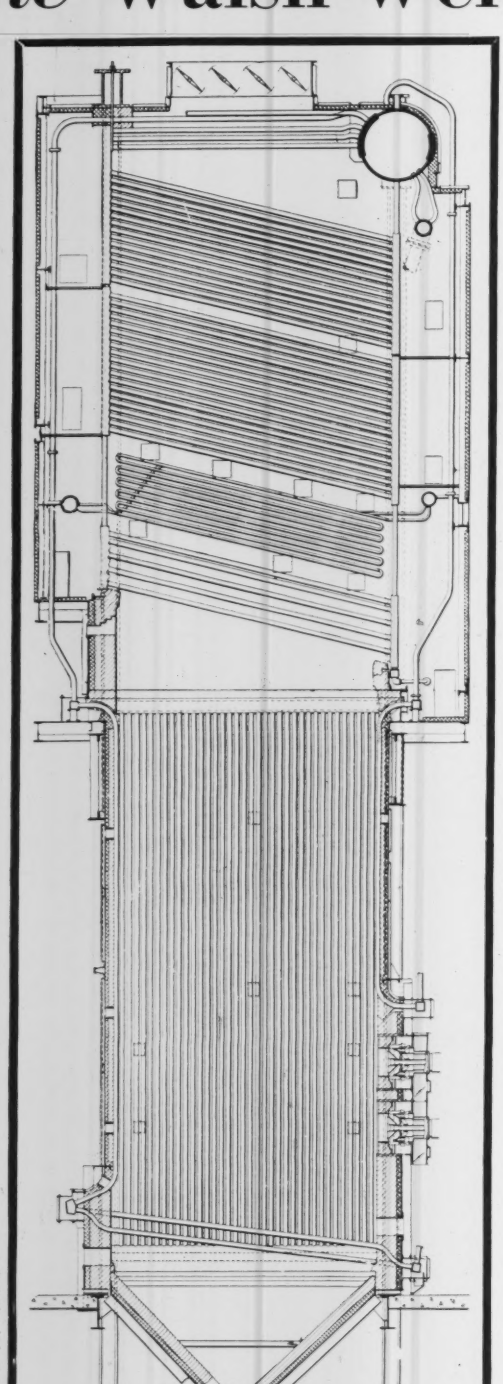
MECHANICAL ENGINEERING

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

January 1931

One Walsh-Weidner Forged Steel Sectional Header Boiler *to serve a* 25,000 kw. Generator



Sectional elevation of the Combustion Engineering steam generating unit now under construction at the Duluth Steam Electric Station of the Minnesota Power & Light Company.

The Walsh-Weidner sectional header boiler to be installed at the Duluth Steam Electric Station of the Minnesota Power & Light Company is believed to be the largest sectional header boiler ever built.

This Walsh-Weidner forged steel sectional header boiler contains 36,300 sq. ft. of heating surface; is of single pass design, 38 sections wide and 43 tubes high, including 3 rows of circulators. The steam pressure is 485 lb. per sq. in. with a total steam temperature of 760 deg. fahr.

The furnace is of the C-E Water-cooled wall construction and pulverized fuel is introduced through six Lopulco horizontal burners.

This installation is an excellent example of the rapidly growing trend of—one boiler per generator.

COMBUSTION ENGINEERING CORPORATION

200 Madison Avenue **New York, N. Y.**

BOILERS - AIR PREHEATERS - STOKERS - PULVERIZED FUEL EQUIPMENT - WATER-COOLED FURNACE

Mechanical Engineering

The Monthly Journal Published by
The American Society of Mechanical Engineers

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Glorious Opportunities Ahead

IN THE annals of The American Society of Mechanical Engineers the year Nineteen Hundred Thirty will be forever memorable through the splendid celebration which commemorated the brilliant achievements of its first fifty years. The past has fully justified itself, but what does the future hold? How well prepared are we to meet its demands and its problems? We can safely assume that the Society will become much larger and that its interests will become more diversified in the next half-century. But it will not grow of itself. New subjects of interest must be added; new opportunities for expansion must be opened up; new lines of usefulness must be developed. The American Society of Mechanical Engineers ought to make itself a commanding factor in every field of mechanical engineering, for the profession has for its domain not only the strictly technical problems of industry, but the economic problems as well. There are glorious opportunities ahead. It is for our successors to embrace them.

CHARLES PIEZ.

[Message from the retiring President of the Society read at the Annual Dinner of The American Society of Mechanical Engineers, Hotel Astor, New York City, December 3, 1930]

MECHANICAL ENGINEERING

Volume 53 January, 1931 No. 1

Engineering Encounters Human Nature

By ELLIOTT DUNLAP SMITH,[1] NEW HAVEN, CONN.

TO AN UNPRECEDENTED degree, engineering has achieved its goal. From the time when engineering first emerged as a profession, its aim has been to supply the material wants of mankind through the scientific development of machinery and methods of production. Recently the engineer has made such dramatic progress that the efficiency in production he has made possible has outstripped our efficiency in distribution, and for the time being, at least, we are suffering more from lack of wants to supply than from lack of capacity to supply them. So great have been the fruits of engineering development that there is much justification for saying: no other profession has ever gone so far in the attainment of its goal. But when one considers that the unemployment which has occurred because of the failure of the economist and the business man to devise means for effectively distributing the abundance which the engineer's technological skill has made possible, is called neither *distributive* nor *economic* unemployment but *technological* unemployment, this seems like a half-truth. To round out the truth, one must go farther and say: No other profession has gone so far in the attainment of its goal, *and none has ever been so roundly abused for its success in doing this.*

Not only has the engineer made it possible to produce enough for all men to have what a century ago would have been considered an abundance, but he has made possible equally great benefits in the work and life of the worker. He has removed from men to machines the heaviest burdens of toil. He has made it possible to shorten the 16-hour day to 10 hours and to 8 hours He has made child labor unnecessary. To labor the engineer has thus brought freedom from economic distress, freedom from the heaviest toil, free hours each day and free week ends available for self-expression and self-development, and especially a childhood wholly free from work, available for wholesome play and education. These are not merely changes in physical comforts and well-being: they are wonderful opportunities for developing mind and spirit. Yet to a large extent these gifts are still opportunities, not realities. Just as the economist is still struggling to distribute potential abundance without causing periods of actual want; so our factories are struggling—or should be—with the problem of casting the burdens of work upon the machine without casting the influences of deadening monotony upon the worker. So also our schools are still struggling to make the long, toil-free period of childhood a period of true development, and our sociologists are seeking to convert the new free time of the worker from a time of waste to a time of progress. Yet because the opportunities the engineer has provided are still not fully used, the gifts of the engineer seem to be forgotten. While there is little talk of technological abundance, technological removal of the burdens of toil, technological leisure, or technological child welfare, the engineer, who has done so much, is blamed on all sides for the evils of the machine. Truly, the way of the progressor is hard.

Naturally, many engineers resent thus being put in a position of splendid but maligned isolation by what

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Can we go on and on in our triumphant technological advance and not soon reach a stage where it becomes necessary—not merely desirable—for the great technological organizations of production to be handled by technologically trained men? Do engineers want to let this opportunity for assuming high commands in industry slip from them?

The engineer in launching new technological processes in an old world is not merely putting new wine into old bottles. He is putting high voltage into old wiring. It is an important part of the task of engineering to see that that wiring is made adequate to the new load.

ELLIOTT DUNLAP SMITH.

[1] Director of Industrial Investigations in the Institute of Human Relations, and Professor of Industrial Engineering, Yale University.

Address delivered at the Annual Dinner of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., December 3, 1930.

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seems to be the failure of society to keep abreast of their progress. It is slender comfort to find oneself ahead of the crowd when it exposes one to taunts, not praise. Some engineers, I am told, with the pecuniary tendencies of practical men, translate this sense of not getting their deserts into a sense of being underpaid. Perhaps you know some who do. It is a comforting way to look at the situation, for no matter how much or how little an engineer earns, it does warm his heart to think how much more he would earn if only he belonged to a profession that was paid what it is worth.

Social Responsibility Incurred by the Engineer

Regardless of what form it takes, I heartily hope that engineers do feel resentment. For hurt pride so often goeth before action—and action is needed. The engineer in making technological progress has created great problems. No matter how exclusively he may confine his attention to materials and mechanisms, once his plans pass from ideas into actual machines and processes, engineering encounters human nature, and thereby incurs responsibility for seeing that human nature benefits from this encounter.

Let me illustrate this with a recent example—the automatic loom. Until about a generation ago, weavers had to stand in front of their looms in order, when any thread broke, to stop the loom before the fabric was marred. With the automatic loom, the loom stops itself, and with most stoppages remedies the trouble and starts up again without any attention from the weaver. The automatic loom seemed like an ingenious mechanical device, but nothing more. It was launched into the world with characteristic engineering modesty and unawareness of human consequences. The machine was designed, the designer's job done, and that was that.

But step into a weaving shed today and see what has happened. With the automatic loom, one weaver can now tend more than one loom. At first he tended two, then four, then sixteen, and then still more, until with some fabrics, at some mills, a single weaver now tends over one hundred looms. A weaving shed with 4000 looms that before the invention of the automatic loom would have had 4000 weavers, now may have but 40 weavers and a few unskilled helpers. Amid that sparsely inhabited wilderness of self-controlled machinery one can with difficulty find the scattered workers. It is a graphic symbolization of triumphant technology—the machine is so nearly human and the human element has so nearly been removed.

Inconspicuous as it rendered the human beings, the human consequences still were there. The market for textiles is not insatiable. As one weaver produced more and more textiles, more and more weavers were thrown out of work. Since the whole industry was affected, the weaver was not merely out of a job—his trade had gone. Even the jobs of those weavers who remained were different from what they had been before. In the old power-loom days they had handled the entire task of weaving and were largely self-sufficient: now they were special units in an intricate organization of machines, material, and men, largely dependent in their work upon the accurate maintenance by management of the difficult balance of the interrelated functions. The old-time weaver was only busy now and then—he could not leave his loom to take on extra work. The new weaver, as he tended more and more looms, was geared to ever more intensive activity. The old-time weaver worked in close contact with his management and his fellow-workers. The new was separated from associates and superiors alike by a wide expanse of looms.

Scarcity of work, greater dependence upon management, new intensity of effort, and greater isolation—these were but some of the changes brought about by the engineer. Unless these were paralleled by such new opportunities for employment, better-organized management, shorter hours, better working and living conditions, and some means of effective contact with management, trouble was sure to follow. Where no such adjustments were made, suffering, hardship, and labor unrest occurred. Where the method of the engineer was carried past the provision for mechanisms and materials to provision for the needs of human nature, there was little either of suffering or rebellion.

North and South, the story is the same. With organized and largely foreign labor, or with unorganized American workers, with radicals or with God-fearing, property-respecting people, the same parallels in methods and results have occurred. Nor are they confined to textile developments. Wherever engineering has rapidly developed technological skill, similar problems arise and a similar relationship between methods and results occurs.

Effect of Introduction of the Automatic Loom in Two Cases

Perhaps I can make this clearer by showing the effect of the automatic loom in two actual cases—two southern mills where neither radical nor labor organizer had disturbed the simple, religious, property-respecting individualism of the native white. Both were small mills, each employing less than a thousand workers. Both were in small villages, without sewers or pavements. Five families shared a pump, and there was "running water only when it rained." The mill people were considered social outcasts by their neighbors in the near-by city. They worked 12 hours a day and 65 to 70 hours a week. They earned from twelve to fourteen dollars weekly.

The working conditions in the mills were slovenly and unsanitary. The work was the typical lackadaisical work of the unorganized southern mill, and the management the simple unorganized bossing of the old one-loom-to-a-man days. Under the stress of competition, the automatic loom had been introduced, and gradually the number of looms tended by the individual weaver had increased.

The management of one of these mills—which owned several in the South—decided that rapid increase in the

efficient use of labor on these looms could be made. They employed engineers to study the problem. They did a thorough technical job, improving materials, methods, and conditions, even to the extent of discovering an improved cottonseed, and giving farmers a bonus to induce them to plant it. But they did not stop their engineering there. They realized that the new efficiency they had developed was dependent upon a far greater managerial skill than before in order to maintain its taut adjustments, and a higher grade and better organization of management was introduced.

A new type of labor was also required to meet the demands and the strain of highly developed technological operation. The human material was there, but it could not effectively assume a new productive character under the old operating and home conditions and the old hours. So they cleaned up the mill and they cleaned up and improved the mill village. As the work progressed, hours were reduced and later wages raised.

The adaptation to the new technological efficiency was carried past the production process to marketing. New merchandise and new facilities for marketing were developed. I need not elaborate on the details: the items I have mentioned indicate how the engineering was carried through as thoroughly in regard to human nature as to materials, process, and machines.

The increase in efficiency was gradually carried on—so gradually that no men were laid off, the reduction in crews being effected by the normal turnover. Yet within the span of a few years this mill was operating over one hundred and ten looms to the weaver. As far as I have been able to determine, no other mill has ever been able to operate its looms more efficiently. There was no labor hardship or unrest. During this period of technological progress—"stretch-out," as labor usually calls it—the turnover declined and the mill acquired a large waiting list of workers anxious to secure employment. Although there is no union there, organized labor has publicly pointed it out as a mill outstanding in its treatment of labor. While this mill is outstanding, our recent studies show that it is also typical of the results attained both in the North and in the South of engineering carried through to the end.

The other mill ended its engineering with the introduction of the automatic loom. There was no research. There was no change in management, in living conditions or working conditions—the same foremen and absence of staff, the old working conditions, the old housing, the old hours, and the old pay. The mill had heard that other mills were running fifty looms to the weaver, while they ran twenty-five. So they picked out a sturdy young weaver and told him "to see if he could make a go of fifty." They then told another and another. It was a case of run the fifty or get out. It was "stretch-out" undiluted—the entire burden of increased output thrust directly on the workers.

In a short time in this mill where no strike had ever occurred, where no organization existed, and no organizer had come, a strike became imminent. As one of the workers told me, "A bunch of us fellers got together, and me and two others were sent to see what kind of an organization we should join up with—for it looked like a strike, organizer or no organizer." Before they could get organized labor to send them experienced leadership, a majority of the mill was organized, and in a short time a strike came that lasted for bitter weeks.

Unless one has seen a southern mill village in time of strike it is hard to realize what such a strike means. These people have no funds. Their meager wages have been too small for them to save. The mill owns their houses and their whole community. Usually, even their minister is mill-paid. Their organization is new, and they have had no time to build up union funds. Except for the slender hope of outside assistance, they face starvation and homelessness almost at the start. Even with help, it is a pitiful drag of half-rations and half-shelter. What is significant, therefore, is not the mere fact that there was a strike but that the pain of undigested technological efficiency had driven unorganized religious, native Americans to the desperation that a strike under such circumstances involved.

When Technological Developments Pass From Ideas to Realities, Engineering Encounters Human Nature

These instances perhaps make clearer how, when engineering or technological developments pass from ideas into realities, engineering, whether it wants to or not—whether it realizes it or not—encounters human nature. The engineer not merely contrives a machine, but uproots the work and lives of men. Nor is his technological progress easily absorbed. If suffering is not to occur, some one must take the leadership in seeing that engineering methods are applied to the wholesome absorption as well as to the efficient construction of the machine.

But is this the job of engineers? There was a time when the operation of industry was hardly an engineering task. But as machinery becomes a larger and larger part of manufacture and as machinery and process become more and more technical, doesn't management increasingly assume engineering attributes? Can we go on and on in our triumphant technological advance and not soon reach a stage where it becomes necessary—not merely desirable—for the great technological organizations of production to be handled by technologically trained men? Do engineers want to let this opportunity for assuming high commands in industry slip from them?

It is true that all too rarely have engineers been chosen for the top executive positions from which the technology of engineers in its encounter with human nature is directly controlled. But may not the reason for this be that engineers all too rarely see beyond their mechanism to its effect on human nature? How can we expect engineers successfully to assume even the technological responsibilities of management unless they understand not only materials and machines, but men. For no matter how fully management may be perme-

ated with technique, management will always involve the management of human beings. Indeed, the more management becomes dominated by the engineer, the more clearly will its task become the adaptation of technological development to human nature. The new opportunities for engineers to lead in industry thus entail new responsibilities. Can engineers fail to want these opportunities of leadership in carrying their own achievements forward to new goals? Can engineers hope to be given these opportunities unless they accept the responsibility for adapting mechanism to men as of the very essence of engineering?

Engineers' Responsibility for Adapting Mechanism to Man

But the management of industry does not reach the whole problem. Much of the solution lies entirely beyond the scope of management or of engineering. The distribution of greater production belongs to the business man, the utilization of work-free childhood and ample adult leisure are tasks for the educator and the sociologist. But even though the engineer has no responsibility for doing this work, hasn't he and his profession a responsibility for leadership in seeing that this work is done? After all, these problems of increased wealth and increased freedom from toil are of his making. Can he expect the world to consider him a benefactor because of the opportunities he has provided, if he takes no leadership in seeing that the problems which arise out of them are solved? As engineering goes forward and the problems of society as well as of industry grow more technical, does not the opportunity and the need for engineers to share in the solving of these problems grow greater? Does it not become increasingly their task to participate in meeting the conditions of an increasingly technological age through participation as individuals and as an organized profession, in governmental, civic, and social developments?

The engineer in launching new technological processes in an old world is not merely putting new wine into old bottles. He is putting high voltage into old wiring. It is an important part of the task of engineering to see that that wiring is made adequate to the new load.

The Machinery of the Earth

IN FEBRUARY last year Professor Eddington, in the course of his Thomas Hawksley Lecture, took the members of the Institution of Mechanical Engineers to the stars and invited them to contemplate the amazing forces and conditions which modern research has discovered within them. There were doubtlessly many who expected to hear last Friday evening from Professor Gregory, as a geologist, a continuation of the sublime and stupendous story begun by Professor Eddington, as an astronomer. It must almost have been a disappointment to them to find the lecturer, in his charmingly quiet and convincing manner, giving to the earth a character which can only be described as mundane. Dame Nature, so far as the world we inhabit is concerned, is no serene mathematician, but, out and out, an engineer, working with forces and matter of the same order and kind as those with which human engineers are on familiar terms.

Evidence is available, as Professor Gregory told his audience, which shows that since the beginning of geological time the earth's climate has been on the average similar to what it is today. There have been local variations, but on the whole the warmth received from the sun, the precipitation of rain, the strength of the winds, the activity of volcanoes, and other agencies and forces have, almost since the birth of the world, been of the same order as they are now. The earth, in short, is a prosaically mundane body, and always has been. It is mundane on its surface, and, so it would seem, equally mundane in its interior. There is no geological evidence for the existence of celestial temperatures within the earth. From the observed rate at which temperature increases in deep mines, the earth at its center ought to be at about 400,000 deg. fahr., a chilly temperature compared with that of the stars, but still one sufficiently above our common experience to be classed as extramundal. Geology offers no actual evidence of a temperature at the earth's center of more than a few thousand degrees, say, 5000 deg. fahr. That temperature is within what man can command. It is well inside the range which we may call mundane. So, too, as regards the composition of the earth. The evidence derived from a study of meteorites, and independently from a study of the propagation of earthquake waves, suggests or proves that our globe consists of a relatively thin stony crust overlying a thick shell of solid nickel-iron, within which there is a fluid core of the same metals. The fluid core has no such density as that which, according to Professor Eddington, exists in the stars. It is under compression, but its specific gravity, it seems, is only about 12. It is actually less than the specific gravity of mercury, tungsten, and platinum, and is roughly only about half as much again as the specific gravity of nickel and iron as known to us on the earth's surface. The world is mundane, and so, too, are the only other fragments of the universe with which we can make direct contact, the meteorites which fall in immense numbers annually on our globe. The stony meteorites are chemically and petrologically identical with the matter in the stony crust of the earth. The metallic meteorites are of iron-nickel, like the earth's interior.—*The Engineer*, Nov. 14, 1930, p. 543.

Progress and Prospects in the Field of Mechanical Engineering

A Review of Recent Accomplishment in Its Various Branches, Prepared by the Professional Divisions of The American Society of Mechanical Engineers

FOREWORD

FOR six years the Professional Divisions of The American Society of Mechanical Engineers have presented reports of progress and prospects covering a period of 12 months at the Annual Meeting of the Society in December. These reports are prepared by committees and individuals who have at their command the records and opinions of experts in the branches of engineering which they represent. They constitute one of the most valuable contributions made by the Professional Divisions of the Society to technical literature and history. By reading them engineers obtain a typical cross-section and a critical review of engineering accomplishment in mechanical engineering and a basis for planning future activities in their own and related fields.

The task of preparing these reports requires much time and hard work freely given by the committees and individuals who are the authors. To these men the Society and the profession are deeply indebted. Acknowledgment of this debt is gratefully made in the name of the Society.

CHARLES PIEZ,
President, A.S.M.E., 1930

Progress in Aeronautics[1]

Contributed by the Aeronautic Division

Executive Committee: Charles H. Colvin, *Chairman*, Alexander Klemin, *Secretary*, Wm. F. Durand, Thurman H. Bane, Porter Adams, Wm. B. Mayo, and Edwin E. Aldrin

AERODYNAMICS

IN THE field of aerodynamics, progress has been made in the provision of research facilities. The first full-scale wind tunnel in the world is being built at Langley Field by the National Advisory Committee for Aeronautics. The same committee has completed a new vertical-type tunnel equipped with a dynamometer for autorotation tests of airfoils and model airplanes. Several other tunnels have been built by industrial corporations (Sikorsky Aviation Corp., vertical-type wind tunnel, and B. J. Aircraft Corp., open-jet double-return type) and educational institutions (California Institute of Technology, large single-return type). The slotted wing is receiving an increasing amount of attention. The calculations made by Tchapliguine indicate that a wing of this type may provide increased inherent stability. The recent development in England by Handley Page of the slot-and-aileron type of lateral control with an "interceptor" for increasing the effectiveness of the "up" aileron by spoiling the action of the slot on the wing to be depressed, has greatly minimized the dangers of a so-called "flat spin."

Speed seems to have been the general aim this past year, and many designers have been willing to sacrifice a certain amount of pilot's vision in order to attain as much speed as possible. Streamlining and close study of the aerodynamics of existing production types are evidenced by the new lines, fillets, and fairings on many types of the previous year—notable among these being the three-engined Ford.

AIR TRANSPORT

The twelve-month period following that covered in the progress report for 1929 has been one of more or less continued development in air transport despite the effects of overexpansion on the manufacturing side and the general depression in business, both of which became very acute at this time. While flying schools felt this depression severely and while private flying did not continue the expansion of the previous period, the mail operators and the regularly operated passenger routes showed some substantial increases in traffic as well as some further extensions of air lines.

Air-mail volume continued to grow more or less regularly throughout the earlier part of this period, but a peak was reached in October of 1929 and an appreciable drop followed, the bottom being reached about January, 1930, after which the volume began to climb back toward that of the previous peak. A large part of the 1929–30 winter slump may be charged against weather conditions, which always interfere with air-mail operations in the first few months of the year, and which early in 1930 were usually bad for the maintenance of regular flying operations. It is evident, however, that the failure of the air mail to continue its growth is not fully explained by weather, and it seems

[1] Abridged. The complete report will appear in an early issue of *Aeronautical Engineering* (Trans. A.S.M.E., Contributions of A.S.M.E. Aeronautic Division).

probable that the general business depression was one of the underlying causes.

Early in 1930 several of the larger operators put into effect drastic reductions in passenger fares, bringing the cost of travel by air very close to that of travel by rail, and in at least one case the air-line was made slightly less than the rail fare for the same trip. Public response to these reduced rates was practically instantaneous, traffic on many lines doubling almost overnight, while the increase in some cases reached as high as 400 per cent in a comparatively short time. After operating for several months at the reduced rates, some of the lines put into effect new tariffs carrying a slight increase over the rates in effect for a few months previous.

The total number of accidents has been steadily increasing —for example, 52 men were killed among the Army fliers— but the ratio between the total number of accidents and the total miles flown has been showing a steady improvement. In civilian flying stunting and carelessness represent two important contributing causes of accidents at present. However, in 1930 the Department of Commerce began to apply its regulations with greater rapidity.

The total number of airports and landing fields in use in this country during the period covered by this report increased from 1224 as of January 1, 1929, to 1527 on November 4, 1929, and 1655 on July 1, 1930. At the time of writing these airports are divided as follows: 500 municipal, 558 commercial privately owned, 79 army and navy, and 518 Department of Commerce and other intermediate or emergency fields and other Government fields. Considerable extension was made in lighting airways in this period, continuing the development program started a few years ago by the Department of Commerce Aeronautics Branch, and 583 airports and fields are now lighted. While considerable study has been given in various quarters to the design of airports, at present very little effort appears to have been made to apply this information in actual practice, due possibly to the tendency of many municipalities to place the entire design of their airports in the hands of the existing city engineer's staff without calling for aid from the aviation industry.

Naval Aviation

In the field of naval aviation satisfactory progress is being made toward the completion of the five-year building program for naval aviation as authorized by Act of Congress, June 24, 1926.

A step in the solution of our difficulties in the use of aluminum alloys in the construction of hulls and floats has been the discovery that incorrect heat treatment has been responsible for much of the rivet corrosion. Tests indicate that improved methods which will insure all rivets of obtaining correct and uniform heat treatment, will largely eliminate this trouble. After experiment and service tests the anodic treatment, whereby aluminum and aluminum alloys are given electrolytically a coating of aluminum oxide, has been adopted as the standard method of preparing these materials to receive paint finishes. This treatment not only provides a surface to which finishes adhere readily, but one which has also considerable corrosion resistance in itself.

Good progress has been made in the construction of the airship *ZRS-4* (U.S.S. *Akron*). This airship will be equipped with German Maybach engines, but the Bureau of Naval Aeronautics has ordered two compression-ignition heavy-oil engines for experimental purposes. Rigid-airship operations throughout the year have shown definite progress toward the solution of the problem of handling large airships mechanically. The mobile mooring mast has become a regular part of the handling equipment.

A very important development in ground handling has been the use of the mobile stub mooring mast at Lakehurst.

Military Aeronautical Developments

Among the developments in Army aeronautics may be mentioned two new types of airplanes—photographic and basic training. Engine developments have been carried along two lines—direct air cooling and liquid cooling, particularly the latter, where the substitution of ethylene-glycol for water as a cooling liquid has permitted considerable improvement—for example, reduction of the size of radiators. At first troubles were encountered when this method of cooling was applied to engines in excess of 500 hp., but these have now been largely overcome.

The testing of a 1400-hp. (at 2000 r.p.m.) air-cooled 24-cylinder "X" type of engine for securing engineering data has proved interesting. This engine has four rows of six cylinders, each with a $5^3/_4$-in. bore and $7^1/_4$-in. stroke, set at 90-deg. intervals about a 6-cylinder-type crankshaft. When tests are completed upon this 4520-cu. in. engine, excellent data on the behavior of air-cooled cylinders in large sizes should be available.

Less spectacular but of far-reaching importance is the development work on fuels making possible the use of higher compression and greater supercharging, with the attendant fuel economy. Studies in the torsional vibration of engine crankshafts by means of a newly designed torsiometer have resulted in correct counterbalancing and the determination of certain speeds which should be avoided in regular operation. A graphic record showing distortion or twist of crankshaft is easily obtainable at any desired speed.

Two other developments include the automatic supercharger regulator, whose operation is governed by the change of barometric pressures due to altitude, and the solid-fuel-injection system using a fuel pump and spray jets for improving the fuel distribution.

As regards the airplane proper, there is a marked tendency in favor of monoplanes. In construction the tendency appears to be toward the all-metal machines incorporating the smooth-surface monocoque type of fuselage and wings whose structure and covering are metal. The use of duralumin construction is undoubtedly growing, although again the majority of machines in actual use today are of the steel-tube, welded-joint type. Many studies have been carried on with a view to reducing the resistance and the weight of structures of a given strength in order to increase the performance. A short discussion of the airplanes in present use, and a word about the tendency of design in each of the basic types, may prove of interest here.

A new type of transport plane which will be used by the Service this coming year in limited numbers is the Fokker high-wing C-14. With its plywood wing raised 18 in. above the fuselage and the pilot mounted in an open cockpit aft, it should prove useful for transporting supplies, spare engines, etc. For many military requirements the lighter single-engined transport appears more practicable.

In the experimental field in this class the Fokker O-27 provides a most interesting exhibit, combining a cantilever wood wing in which two Prestone-cooled Curtiss Conqueror engines are streamlined, a small-section steel-tube fuselage, and a retractable landing chassis. The pilot and two observers sit in open tandem cockpits. Performance trials are now under way to determine its suitability for Service use. To the casual observer on the ground watching it pass, its two 600-hp. engines wide open and its landing chassis drawn up into the engine nacelles, it seems like a step in advance. Speeds in the 1929 pursuit class are hoped for, but only time will tell.

That the pursuit plane must look to its laurels if it is to maintain a liberal margin of high speed over certain larger and heavier

types, seems to have been demonstrated in British maneuvers in the defense of London. Light bombardment planes of the two-place class powered with water-cooled engines made a splendid showing, and did not appear to be particularly worried by the pursuit machines.

In our Service the Curtiss Hawk P-1C and the Boeing P-12C are the two standard types of pursuit. The P-12C incorporates certain improvements, among which is a ring cowl about 12 in. wide; the visibility is not materially reduced. In order to gain increased performance at higher altitudes, the supercharger blower is geared 10:1. By careful handling of the throttle and not overloading the engine at ground levels, reasonably satisfactory maintenance may be expected. Full-capacity operation should take place only at altitudes above 8000 ft. With its short span and compact weight arrangement, it is a very maneuverable machine. The fuselage construction is of the square-tube, rounded-corner duralumin longeron type, riveted and bolted.

The Curtiss P-6 pursuit airplane powered with a 600-hp. Prestone-cooled Curtiss engine will soon be equipped with the new improved Conqueror engine designed especially for Prestone cooling and will then be given additional service tests.

The present tendency in pursuit development is to increase the high-speed performance, particularly at altitude, by the use of engines of greatly increased horsepower which are more highly supercharged. In all probability future development in this type of machine will swing toward the smooth-surface all-metal fuselage and metal-covered wings. Duralumin construction will undoubtedly play a most important part in this development. The surprising increase in speeds of larger and heavier machines is forcing the pursuit to reduce resistance to the minimum and to use overpowered engines. The use of retractable landing gears, and even an inclosure for the pilot, have been suggested in the past and may be given more serious attention than heretofore.

Airships

As regards lighter-than-air ships, the *Graf Zeppelin* has continued in successful service throughout the year. This airship has now crossed the Atlantic Ocean seven times and the Pacific once, the former including flights to North and South America. The British airship *R-100* made a round-trip voyage from England to Canada and back, but not without having wrecked the fabric from both horizontal fins on the Western trip. She remained in Canada for about two weeks on a mooring mast, without the protection of a hangar. The second British ship, *R-101*, crashed in France and was completely destroyed by fire. This report would not be complete without reference to the very extensive improvements which have been made in landing fields and in the lighting of airplane lanes.

Progress in Materials Handling[1]

Contributed by the Materials Handling Division

Executive Committee: G. E. Hagemann, *Chairman*, M. W. Potts, *Secretary*, F. D. Campbell, C. D. Bray, E. D. Smith, and F. L. Eidmann

THE quiet business conditions of 1930 have stressed upon manufacturing plants the need for making increased use of facilities to lower the cost of production. Materials-handling equipment offers one of the most definite means for obtaining continuously lower production costs not only through the substitution of mechanical operation for manual labor but also through the elimination of useless steps in the manufacturing cycle.

Overhead Traveling Cranes

In overhead traveling cranes the main improvements have consisted in the further use of anti-friction bearings, improved lubrication, and flexibility in design. The principle of handling carload shipments in containers has been applied to shipments of welded pipe, which is stored in unit frames, and when shipped, the entire frame is lowered into the car. An automatic grapple has been produced for handling rolls of paper used in the manufacture of containers, and similar devices have been developed for the rayon and dyeing industries.

Electric Hoists

There is now a general use of heat-treated steel gears, of special-steel shafts, and higher-speed motors of special design for hoisting service only. The lack of lubrication being the greatest cause of trouble, there is a constant endeavor to cut down the number of places to be oiled or greased, so that no place will be overlooked.

New cage-controlled monorail hoists, in small capacities, have been developed to meet the overhead-transportation problem. These hoists can transport small loads at high rates of speed around curves of small radius through narrow-throw switches, and operate on a system of transfer cranes.

Heavy, rugged, cage-controlled monorail hoists have also been designed to perform work hitherto delegated to 5- or 10-ton-capacity overhead electric traveling cranes. These cage-controlled hoists are now designed to furnish the extremely long lifts that are required for grab-bucket and magnet service.

Conveyors

Coal-handling equipment of the full-automatic, trolley bucket-conveyor type has been designed and developed for the retail coal yard so that coal can now be handled entirely automatically and with a minimum of breakage. It consists essentially of a hoisting unit for raising and lowering the bucket, and a traversing unit that controls the horizontal motion of the bucket over the various bins. It is necessary only to push the "start" button and the large bucket lowers into the track pit, tripping the loading gate, which permits the bucket to fill with coal. The bucket remains in the pit for an interval of from seven to fifteen seconds, the length of this interval being adjustable and of a duration sufficient to enable the bucket to obtain a full

[1] Abridged. The complete report will appear at an early date in Trans. A.S.M.E. (Contributions of the Materials Handling Division).

load of coal. It then immediately ascends to the trolley, where it stops automatically; the trolley then starts up and carries the bucket to a predetermined bin, where it automatically stops.

Somewhat similar devices have been developed for the ice industry. Among them are multiple cake conveyors, spiral lowering chutes, and power transfer conveyors.

The power transfer makes it possible to synchronize two conveyors at angles to each other and eliminates the danger of ice jams and breakage at the transfer point which are liable to occur when the gravity run is depended upon to transfer the ice. In using the power transfer, it is possible to convey the ice by means of a system of conveyors from any part of the plant to any other part without any labor beyond that of placing the ice on the first conveyor. The unit is very flexible in application, and it can be installed in any plant, regardless of conditions.

Among the improvements in conveying equipment may be mentioned also a live-roller curve using the same principle as used on the live-roller conveyor, i.e., a belt running underneath the load-carrying rolls and held in place by tension rolls. Next comes an alligator switch to shift packages from a single line to two or more lines or to receive them from several lines on to a single line. Likewise an alligator-switch section operated electrically has been developed to deflect packages or boxes from a main conveyor to any of several branch lines. The alligator switch may be equipped with electric remote control. The automatic selective vertical elevator discharges the proper load on any floor and can handle even such delicate jobs as packages of grinding wheels, which might be injured by spillage. The automatic reciprocating elevator as now developed usually serves two floors and is used for lowering packages. A number of conveyors have also been developed, such as the apron conveyor and the escalator or tiering machine. On these weights up to 100 lb. can be handled, and the traveling speed of the package is 90 ft. per min.

The foundry industry has now available equipment for the transportation of green-sand molds and core assemblages, made possible by the development of the sand-sealed ball bearing which can be operated for years without relubrication and is capable of withstanding continuous spillage of molten metal.

Belt Conveyors

A number of useful developments have occurred in the belt-conveyor field: for example, the rubber brush for cleaning conveyor plates, and the hold-back rig to prevent the belt conveyor from running backward under load when the power is shut off. A rubber-cushioned idler is used under the loading points of conveyor belts carrying large pieces of heavy material which are delivered to the belt with impact. As accessories to conveying machinery, combination feeders and crushers have been developed, for example, for service in plants where coal is received at times in a frozen condition. In this device the coal is drawn in over a large roll and crushed between a large and a small roll. Other accessories are the "avalanche" and "withdrawal" chutes used in lowering friable material from conveyors into bins and withdrawing it from the bins. These not only increase the flow of material but effect remarkable savings in degradation.

Chain Conveyors

Progress in the chain-conveyor field has in general been confined to improvement of design detail and to the more extended use of existing types of equipment. There is appearing also a tendency to make the conveyor a definite part of the production process, as has already been done in the automotive field. The idea contained in the continuous molding conveyor, now so generally used in all large-production foundries, is being applied successfully to other processes, and it would appear that this development should have further and more intensive study.

Of the different types of chain conveyors available, particular reference is made to the power-driven overhead trolley conveyor and the single-strand dolly, or truck, pusher conveyor of the "on-edge" type, i.e., with the chain operating with the pins vertical.

Chain conveyors which have been extensively used for progressive assembly in automobile plants are now applied elsewhere, particularly in the newer industries, such as radio, electric refrigeration, and the like. They are also employed in connection with high temperature in such processes as heat treatment, porcelain enameling, core baking, etc. The fabrication of chain conveyors has been facilitated by the use of the electric arc.

As regards details of conveyors, cast chains deserve particular attention because they have now attained a combination of high tensile strength and great wear resistance. This is effected by using malleable iron processed in a new way. High-carbon cast steel and manganese steel are also available, but more expensive than malleable iron.

In the field of skip hoists a unique, clever, and simple loader which automatically controls the filling and operation of the skip bucket has been developed during the past year. With this device, which requires no weighing mechanism, the bucket is hoisted only when it is fully loaded. It remains in loading position until filled, when it is immediately hoisted and continues to be hoisted, dumped, lowered, filled, and hoisted as long as sufficient material is available to load the bucket.

For pneumatic tubes a new type of terminal has been introduced which is made of light metal and harmonizes with the decorative surroundings of the place where it is installed.

Hand Lift Trucks and Portable Elevators

The outstanding development in the hand-lift-truck field during the past year has been its greatly increased use in connection with the shipment of goods on skid platforms. The growth of skid shipping has continued in the paper industry until nearly all customers specify skid packing, due to the saving in cost and greater ease in handling. In the larger cities, most trucking contractors have equipped themselves with hand lift trucks to handle skidded shipments consigned to printers and jobbers. An increasing variety of automotive assemblies are now shipped to assembly plants on skids. Skidded shipments of slate, firebrick, canned goods, and other similar commodities are now being transported both by rail and water at a substantial saving in packing, handling costs, and damage to goods.

In the portable-elevator field a large increase is noticeable in the number of special machines designed to perform operations that previously were considered as requiring brute strength. Among the many types which are coming more into general use may be mentioned: warp-beam carriers, barrel- and drum-lifting machines, oil-switch-tank lifters, refrigerator cranes, die lifters, and special-purpose machines for handling large work in process.

Many machines are handling loads not exceeding 200 to 300 lb., and to make the machine as light and portable as possible, special section members are often used, constructed by arc welding.

Electric Industrial Trucks

During the past year, electric crane trucks have been developed with a rated capacity of 42,000 ft-lb. overturning moment. Another machine has been placed inservice at the Jones & Laughlin plant which has a bifurcated platform and handles 20,000-lb. bosh tanks in the tinplate mill. Ram trucks, in general, have been limited in capacity to 3000 and 4000 lb. How-

ever, by using an articulated front axle, a truck is now made that will handle 8000 lb. These machines have also been developed with a twin ram instead of a single one. By the use of counterweights the capacity of the fork-type truck has been increased to over 10,000 lb. This year has also witnessed the increase of drawbar pull in tractors, the maximum available now being 7500 lb. In these machines the hoisting speed of cranes, lifting height, and maneuverability of the equipment have been materially increased, and a number of new attachments have been developed. Some of these trucks are provided with hydraulic lift and similar devices.

GASOLINE TRUCKS AND TRACTORS—ELEVATORS

Twelve new gas-powered tractors and lift trucks have been introduced during the past year.

The efficiency of freight elevators has been materially increased. The micro-leveling feature on freight elevators is rapidly coming into general use, because by bringing the car to exactly the floor level it obviates the possibility of damage to trucks or merchandise when the former are run on and off freight elevators. In smaller freight elevators where the service does not require an operator constantly on duty, the double-button type is rapidly superseding the old-style hand-rope control. In this type the elevator is operated from each floor by the pressure of a button, which calls the elevator to that floor if it is not already in use. Greater attention to freight-elevator problems is urged.

MOTOR TRUCKS

So numerous and so complex have been the year's developments in the motor-truck industry, that any attempted report must be confined to a few generalities in order to conform to prescribed space limitations.

Most significant is the increasing tendency of industry to appreciate the flexibility with which trucks can be adjusted to the individual traffic and materials-handling problems of manufacturers. As an outgrowth of this realization, motor trucks are coming more and more to be regarded as highly specialized units of machinery, each designed to perform a specific type of operation with the utmost efficiency.

The field of use of this kind of equipment has been greatly increased, as, for example, by railroads in developing their shipper-to-consignee service.

Extension of operating radii is predicted by two additional developments—sleeping compartments in truck cabs for relief drivers, and radio receiving sets for trucks. While the last-named development has not yet been so used, traffic experts are seriously considering the possibilities of short-wave radio equipment in the dispatching and routing of trucks.

CAR DUMPERS, BRIDGES, AERIAL TRAMWAYS

In a car dumper built for the New York Central Railroad at Toledo, such new features as a car retarder on the cradle have been introduced together with a novel arrangement of ropes and sheaves. Novel features are also found in the new Hulett unloaders recently installed at Presque Isle dock of the Hocking Valley Railway Company at Toledo.

Among the outstanding developments in bridges in the past year is one connected with a large gantry bridge built for the Consolidation Coal Company (North Western Fuel Company) for their Milwaukee, Wis., coal dock. This bridge handles a 10-ton coal grab and has been developed to operate on 440-volt, 3-phase, 60-cycle alternating current. Most of the man-trolley bridges developed in recent years have been for use on direct current, in order to obtain the advantages recognized as inherent in direct-current service.

This alternating-current bridge, however, has more than met expectations in that the combination of regenerative braking with graduated air braking gives full control of all movements of the man trolley itself, as well as of the grab bucket. This system has worked out very successfully.

As regards aerial wire-rope tramways, an interesting instance is a double reversible type of tramway installed by the American Steel and Wire Co. at a sand and gravel plant to carry raw material from the pits to the screening and washing plant on top of the storage bin. The same company has developed an automatic tripping carriage in which, by merely reversing the direction of the tramway carrier, the carriage operates levers of the bucket, which discharges the load before the carriage has traversed 30 in. in the reverse direction. The outstanding advantage of this device is that the dumping point on a reversible tramway is not dependent on any attachments on the track cable. Tramways of different types have been installed at banana plantations, at collieries for waste-disposal service, etc. An improvement in the design of grip sheaves for the high-speed transmission of power by wire rope under high tension has been made by a design in which the jaw pins are eliminated.

ELECTRICAL EQUIPMENT FOR MATERIALS-HANDLING MACHINERY

The application of electrical equipment to materials-handling machinery has been greatly extended. Perhaps the most interesting and novel development has been the use and proposed use of electronic tubes for controlling such machinery. In one case, where the amount of material fed by one conveyor on to a second conveyor must be kept proportional to the amount of a different kind of material already being conveyed by the second, this result is accomplished by a thyratron control, which varies the speed of the first conveyor motor in proportion to the weight of material conveyed by the second. The second conveyor crosses a weigh pan located ahead of the discharge of the first conveyor, and the slight up and down movement of this pan due to the varying weight controls the grid circuit of the thyratron, which in turn controls the speed of the d.c. motor on the second conveyor by varying its field. Thus the proportions of the two materials mixed together on the second conveyor are kept very close to constant.

A photoelectric tube is used to provide interlocking between two machines on a grain-car unloader so that the second movement cannot start until the first is completed. It gives greater accuracy than a limit switch will give for this duty, avoids mechanical and electrical wear and tear, avoids the use of gearing or chain drive, and a failure of the tube or light source introduces a safety feature, because it prevents operation of the second motion, thus notifying the operator that it needs attention.

Remote control has been installed successfully in several places—for example, on the cableway at the Owyhee Dam in Oregon, and on the riderless transfer-car system for handling stone out of a quarry.

A rather unusual type of materials-handling equipment using electric drive is a railroad ballast cleaner which has operated long enough to prove its worth. This machine digs the rock ballast from between the tracks with grab buckets, which dump it on a conveyor, from which it goes through a screening and cleaning process. It is then deposited between the tracks again.

Novel use is made of a small electrically driven hydraulic device for operating a safety emergency brake on contractors' hoists in New York City.

In a newly designed electrical remote-control variable-speed transmission the speeds may be regulated from one or more push-button stations, while another electrical control provides entirely automatic speed regulation for certain requirements. A number of instances where speed-varying equipment has been installed are cited in the original report.

Progress in Industrial Management

Contributed by the Management Division

Executive Committee: Chas. W. Lytle, *Chairman*, Geo. W. Kelsey, *Secretary*, Wm. B. Ferguson, H. M. Hubbard, G. E. Hagemann, and F. E. Raymond

THE difficult conditions of 1930 have given renewed impetus to all divisions of management, but particularly to such divisions as marketing, stabilization, control of overhead, and in some cases to research. As well-built buildings remain standing after an earthquake, so certain organizations have been able to show good results despite the economic upheaval. While all companies have been hard pressed, yet there have been many instances of foresight in which management has considered the long-run possibilities as well as the present circumstances. Apparently companies are less bound by history and precedent to continue policies laid down by the founders of the business, and they are less inclined to go to extremes merely for psychological reasons. But nearly every company has had to find ways and means for securing satisfactory returns on its investment from a smaller volume of business, so that every measure has been tested as never before. Thus a certain clarification is being made which will distinguish between practices which are sound for the long run and practices which are only temporarily expedient. In short, the hard times have been beneficial to management, if not to immediate profits. For the first time in a century we have avoided increased labor conflict during a depression.

A survey was recently made by the Management Division in which its members were asked to indicate the relative importance to them of fourteen different subdivisions, making in all what we consider the complete field of manufacturing management. The subdivision designated as Administration received the highest interest consistently, through first, second, and third choices. In the first choice, Marketing came second, but in the second and third choices, Financial Control was given preference over Marketing. The subdivision designated as Plants came next in the first choice, but Production Control went above it in the second and third choices, and Personnel went above Plants in the third choice. Job Standardization came next in the first choice and was fairly high in the second and third choices. We consider this significant of the broadening of interest which engineers are taking in the large problems of management.

Budgeting—Costs

Budgeting is being done more carefully, so that all expenditures can be kept in proportion to accomplishments. The old formula, income minus costs equals profit or loss, has given way to the new formula, income minus profit equals allowable expense. With this conception, standards are being set up for raw materials, methods of purchasing, reduction of inventories, greater labor efficiency, savings in administration and selling, readjustments of commodities, concentration of products, etc. Budget troubles have not been entirely due to inefficiencies, but frequently to new problems for which there have been inadequate facts.

The old practice of averaging profits and losses is rapidly passing. Each line is made to carry its own expense, and much simplification of size, style, and variety has consequently followed. Standard costs have spread until it is confidently asserted that they can be used anywhere if it is really desired.

Expense Reduction

The principles of scientific management have been widely applied to the reduction of direct labor costs, but in that very process many companies have increased their overhead expenses actually and also proportionately to direct labor expense. While overhead expense is made up of fixed, semi-fixed, and variable items, fixed items usually predominate and constitute a distressing problem in the time of decreased volume. Whether or not overhead can be radically decreased in dull times, it should always be controlled so that the management may know what results may be expected for each dollar of overhead expenditure. Comparatively little has been done in this direction, but at the recent meeting of the American Management Association in which this subject was considered, there were many constructive papers submitted and unusual interest was shown. In this field at least it would seem that the principles of scientific management have not been applied to anything like the extent to which they have been accepted in theory.

Scientific Distribution

For some years past, it has been realized that it was futile to save pennies in production and throw away dollars in distribution. Experiments in distribution have therefore continued and some progress has perhaps been made, but not sufficient to allow much specific discussion. The United States Chamber of Commerce has stressed the problem, and many individual organizations are trying to solve their particular problems.

An English writer[1] has reminded us that however true the perpetuality of wants may be, we shall always have periods of overproduction until the mass level of income is higher and the difference of the extremes is less. This puts the high-wage theory in a more fundamental light. If there is hope in this direction, then we in America are at least going in the right direction, but according to this writer we have yet a long way to go. In this connection we regret to say that there is much fallacious thinking in the matter of buying to make work. It may be unanswerable to say that we should have more wearing apparel and more household commodities, but if a manufacturer were to follow this reasoning he would buy equipment and inventories only to keep them idle. If that is uneconomical, then extravagant personal buying is also uneconomical.[2]

There is some encouragement in the fact that instalments on time purchases have been met much as usual.

The Walworth Company has studied its lines in regard to profit, and has removed the salesman's bonus on non-profitable lines. It has also concentrated on customers habitually placing large orders with the belief that small orders will take care of themselves. This policy was the result of a careful study of profit and of inventory. The company claims that a large volume times a small profit per unit is just as good business as the smaller volume times a large profit per unit. This company has long used forecasting to level off its peaks and valleys.[3]

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[1] J. A. Hobson, "Rationalization and Unemployment."
[2] *The New Republic*, July 16, 1930.
[3] Barber, "Budgeting and the Business Cycle."

MERCHANDISING

Competition has forced manufacturers and dealers who would be successful to give increasing attention to the science of marketing, including the vagaries of consumer's psychology. There has been increased appreciation of the fact that as a rule it is necessary to market those commodities which the consumer wants or can readily be brought to want, rather than those articles which the industrialist desires to manufacture for reasons of his own.

Within the last two years the Government and private institutions have been carrying on what might be called a census of distribution, included in which was the Louisville grocery survey. Out of this very important research are coming many conclusions which will be of immense benefit in efficiently merchandising the country's commodities. For example, it has been demonstrated that it is poor policy to overload the buyer, and as a result the manufacturers are adopting a new sales technique and are assuming more of the warehouse requirements formerly borne by the distributors. As a direct result of this census, experts have come to the conclusion that a new point of view is needed in the merchandising of commodities—that performances should be considered with greater emphasis, rather than the mere form of organization. In other words, it will be the competent distributor versus the incompetent, or again, selective distribution versus 100 per cent distribution.

SHIPPING AND PACKAGING

The merchandising world has witnessed what actually amounts to a stampede of changing package designs. This has been due to the fact that the modern wrapper is now considered a show window. The old theory that it would be suicidal to change an established design has in many instances been thrown by the board with remarkably successful results. It has been clearly demonstrated that style has become of great significance to the merchandising of almost all commodities, and that quality without style will seldom lead to success. As a result we are now finding color and other attempts at art in the most surprising places. This applies to both product and container. Glassine wrappers have been extended rapidly to cigars, silk garments, towels, etc. Special automatic machinery has also been developed further to aid packaging. "Uniquity," a term applied by Crosby Field[4] to indicate the unique character of any brand or company situation, now becomes an asset to achieve and maintain rather than the liability which it is claimed to be by critics of our manufacturing system.

RESEARCH IN GENERAL

It is becoming increasingly evident that industrial management must grow along scientific lines rather than by development through the sheer force of circumstances. Research as an aid in developing new and more effective techniques of control, is therefore being more generally adopted by industry. Due to the fact that industry demands of management immediate development of practical procedures in order to keep pace with the changing demands of the times, the majority of these studies in management are more of the nature of applied research than they are of fundamental research. As the exigencies of business conditions become more complex, however, a new interest in fundamental management research will undoubtedly develop.

Recently the Management Division sent out a preliminary questionnaire to approximately thirty-two cooperating engineering colleges requesting information concerning activities in both fundamental and applied management research, with the result that only six replies showed any comprehensive undertaking, and few of these were fundamental. On the other hand, the report of the American Association of Collegiate Schools of Business on the research projects of the member schools, gives excellent evidence of the existence of research activities in business and industrial problems, and incidentally those of management. In those institutions where some form of fundamental research does exist, the subjects are chiefly within the scope of labor relations, wage incentives, safety, service, plant maintenance, plant operation, and production control. In one instance fundamental research applied to the economics of management has resulted in important facts concerning the economies of production and economic lot sizes, in addition to which a new project covering the economic factors pertaining to the selection and replacement of manufacturing equipment is now being undertaken.[5] The outstanding fact is that management is passing through the natural stages of experiment and evaluation which are necessary to the evolution of a science of management.

PLANT EXPANSION—PLANT LAYOUT

There is some indication that more companies than usual have had the courage to expand their plants during the depression; for example, the U. S. Steel Corporation, the Standard Oil Company of Indiana, and the Sinclair Consolidated Oil Company have all taken advantage of somewhat lower prices and have actually created extra jobs. This is encouraging as it shows faith in the future. Andrew Carnegie claimed that he regularly fostered expansion during a depression, and was thereby always ready for the larger-scale work which was sure to follow. Other companies, such as the Royal Typewriter Company, have increased their sales force, particularly their junior sales force.

The suddenness with which processes have been changing recently has led to the policy of keeping buildings as free as possible from special characteristics. This trend is exhibited in the new Ford plant at Edgewater, New Jersey, placed in operation the latter part of this year. This plant follows the single-story plan, which allows for the greatest ease of change, in spite of the fact that it is devoted to the assembly of one of the most highly standardized lines of products—automobiles. The Kearny plant, which the new plant replaces, was housed in a four-story building, with a large main bay upon which the upper floors opened. The design and layout were found to involve too high a manufacturing cost. Hence the single-story plan was adopted for the new plant.

Straight-line flow of production is followed in the new Ford plant and also in the new plant of the Western Electric Company at Point Breeze, near Baltimore, Maryland, recently placed in operation [6]

EQUIPMENT

A study recently made[7] indicated that during the first half of 1930 there was a drop of 18 per cent relative to the last half of 1929, in new or improved types of machine-tool equipment presented to the market. Auxiliary devices, materials, and supplies made a similar drop of 8 per cent. The difference signifies that manufacturers have been less drastic in postponing their purchases of cheaper equipment than in postponing their purchases of expensive equipment. A few lines of equipment, included within the above-mentioned auxiliary group, increased. These were balancing, gaging, testing devices, materials-handling equipment, and transmission equipment. It would seem from this that the problems of quality control, material control,

[4] Trans. A.S.M.E., vol. 52 (1930), paper no. MAN-52-8.

[5] F. E. Raymond, "Economic Control of Manufacturing," forthcoming from McGraw-Hill.

[6] See forthcoming papers, Trans. A.S.M.E., 1931.

[7] *American Machinist*, Jan. 16 and July 17, 1930.

and power utilization are not being neglected. Furthermore the subdivisions of the machine-tool group which go with large-scale manufacture were less affected than were other groups which go with small-scale manufacture. While this study was in terms of the number of types, and neglected the quantity of the types sold as well as the quantity of older types sold, yet it carries some weight.

Illumination

Twelve companies, users of the General Electric illumination service, have made, as the result of their new illumination, an average net improvement of 14.45 per cent in production volume at a cost not exceeding 3 per cent of their payrolls. They unanimously report that, in addition, quality of work is better, conditions of work are safer, and morale of all concerned is higher. The intensity of illumination in these cases is on the average 12.26 foot-candles as compared with 2.86 previously.

Fatigue Elimination

G. A. Penrock, of the Western Electric Company, Hawthorne, Illinois, has been conducting studies in fatigue for several years. He isolates small groups of operators by means of a test room partitioned off from the main work room, and then tries various combinations of influences, changing only one variable at a time. The specific conclusions of the study are as follows:[8]

1 The amount of sleep has a slight but significant effect upon individual performance.

2 A distinct relationship is apparent between the emotional status or home conditions of the girls and their performance.

3 Total daily productivity is increased by rest periods, and not decreased.

4 Outside influences tend to create either a buoyant or a depressed spirit, which is reflected in production.

5 The mental attitude of the operator toward the supervisor and working and home conditions is probably the biggest single factor governing the employee's efficiency.

For most companies job standardization is still the only means of approaching this problem. It is at least accomplishing practical results.

Job Standardization

The application of time and motion study is now spreading within the textile industry, especially in the South. But here and elsewhere we need a better understanding of the purposes and principles of job standardization.[9] Some of the most progressive labor organizations have begun to insist upon the establishment of standards in their occupations. Over fifty companies now have cyclometers on their key-stroke machines.

The General Electric Company has demonstrated the practicality of using the micro-motion method as a means of training its analysts. In fact, they also train their designers in this procedure so that they may avoid designs of either products or jigs which might involve awkward operating methods. Mr. Blakelock of that company stresses the fact that there is nothing so good as micro-motion to give motion-mindedness, and that when this is once acquired it matters little whether the analysts use the full micro-motion method, because they are able to think in terms of motion principles, to set up aids to work, and in short to determine the one best way without being too much influenced by old practices or by considering a product exclusively. When jobs are improved by micro-motion-trained analysts, it is possible to use the stop watch for timing without much impairing the results. This compromise method promises to extend the use of micro-motion more rapidly than heretofore by keeping it simple and reasonably cheap. A few other large companies have already followed suit. For two years now, New York University has been giving a laboratory course in micro-motion. It is the first school to do this outside of Mrs. Gilbreth's own private class.

[8] *Personnel Journal*, February, 1930.

[9] C. N. Underwood and C. W. Lytle, "Job Standardization," forthcoming from Ronald Press.

Financial and Non-Financial Incentives

There has been a revival of interest in financial incentives.[10] This is undoubtedly due to the fact that the high-wage principle has come to the front, and also somewhat to the mature stage which job standardization has now attained. The principle of high wages is standing the test of the depression better than many expected. The United States payroll index for August was 73.9 as against 102.1 a year ago. A survey made in the early fall by the National Association of Manufacturers revealed the fact that 82 per cent of the companies reporting had maintained their wage scales of 1929. Relatively few of the leading large companies have cut wages per piece or per hour. Some have even cut into reserves and dividends instead. They have, of course, shortened hours and frequently have divided work on a part-time basis. The fact that so many leaders are deliberately trying not to cut wages is enough to vindicate the statement that the high-wage theory has come to stay in this country.[11]

As one writer has pointed out, it is unfair to compare profits with wages as a whole since the subsistence of industry is provided before profits are declared. In other words, the true comparison would be between profits and the margin of wage above employee subsistence. In this light it is maintained that we have yet far to go in raising wages consistent with the present productivity of employees.[12] While it is by no means general, yet there are quite a few cases demonstrating that wage incentives can and are being placed on work formerly considered unsuitable for them, such as jobbing, repair and maintenance, drafting, and even development work. In the office field incentives are coming very rapidly. Here mechanization has helped job standardization, which must always precede any good incentive installation.

In an outstanding book[13] Ordway Tead has stressed the importance of making ordinary jobs interesting. The financial incentive is necessary of course, but it may not constitute entire satisfaction. The Gilbreth Research Committee has also been studying the problem of satisfaction, and will have new light on the subject soon. As Florence F. Kelly says after an extensive inquiry into the main sources of happiness, "I doubt whether there would have been, fifty or sixty years ago, so striking a balance in favor of the joys of work, of the happiness springing out of devotion to an agreeable job."

Incentives for Executives

Here the incentive is coming from two directions: first, from profits in the form of a fund and distributed according to the estimated contribution of each executive; second, from measurable achievements such as departmental standards of quantity, quality, delivery, or the all-inclusive costs. We should like to stress our belief that the type of incentive which is based on measured results is infinitely superior for all minor executives, and usually so up to the general manager. For the latter and for those still higher, the profit-sharing fund, if carefully administered, may be suitable. We have much to learn, however, in the matter of establishing standards which can be used for measuring the achievement of executives.

[10] C. W. Lytle, "Wage Incentive Methods," Ronald Press.

[11] A man who is director of several large companies reports that none of these companies has made a single cut in rate. Another man, a vice-president of a small company, was actually hurt when asked if his company contemplated cutting wage rates.

[12] Henry Ford, "Moving Forward."

[13] Ordway Tead, "Human Nature and Management."

PURCHASING

Continuation of hand-to-mouth buying, induced by the continuing decline in wholesale prices, now around 15 per cent, and by the greater flexibility obtained in the face of repeated changes in style and design, etc., has added to the problem of both the buyer and the seller. A much greater control and a more intimate knowledge of facts have been necessitated by these conditions.

PRODUCTION

In the past decade United States factories have produced 42 per cent more with 500,000 fewer employees. Railroads have handled 7 per cent more with 250,000 fewer employees. Coal mines have produced 23 per cent more per employee with 100,000 fewer employees. Competition has placed increasing emphasis upon manufacturing economies as a source of profit, and hence there has been uninterrupted search for better and more effective ways of producing goods. Such developments include products of the research laboratories, such as tungsten carbide cutting steels, and other new products derived from the materials that were formerly waste. Many industries are studying with renewed interest the problem of coordinating production with sales, so as to avoid as far as possible violent fluctuations in the operating schedule. Such researches have not only been effective from the point of view of direct cost of manufactured products, but are of immense social value in stabilizing the employment market. Regardless of the controversial questions raised by this issue, there is no doubt that more study and research must be given the whole question of unemployment by industry at large. Realization of the need for integrated management control has led to the development of merchandising as a coordinating department, which may be illustrated by the Kendall and Dennison companies. Professor Lewis of Harvard University believes that the immediate future will witness increasing developments of such coordinating departments.

ELIMINATION OF WASTE

Elimination-of-waste campaigns and methods sponsored by the A.S.M.E. have been gaining in popularity and interest during the past year. At present there are about 500 American companies that keep in direct touch with the committee. This indicates about double the amount of interest shown a year ago. The waste-elimination meetings in Chicago last spring created much interest, and a prize was offered for the best suggestion made for the April campaign. In the case of larger companies, waste-elimination campaigns have been set up and conducted by a special organization, but in the case of small companies which could not afford this, the committee is putting into shape certain information and data for general use. Among other things the committee has prepared an "Elimination of Waste" dictionary which has to do with the disposition of surplus, inactive, and obsolete materials.

The systematic junking of old automobiles, originated by the Chrysler Company and now adopted by both General Motors and Ford, will not only allow some salvage of materials but should remove unsafe cars from use. This in turn is expected to increase sales slightly.

ENGINEERING LEADERSHIP IN THE WHITE HOUSE

For the first time in history, a President has exerted his influence to mobilize industrial forces for the deliberate improvement of industrial conditions during a depression. The first conference called by Mr. Hoover for this purpose was given three problems to solve: first, the mobilization of credit; second, the maintenance of wages; and third, the expansion of the construction and maintenance work of the country. The men invited to this conference were men able to speak authoritatively for their industries as a whole, but their participation was entirely voluntary. Just how far this influence has extended, it is impossible to say at present, but there are evidences that it has had many tangible results and perhaps still more intangible ones. Many of the committee had already been working in this direction. The very fact that they were called together and that they have sincerely tried to meet the problems is a definite step forward. To quote Mr. Hoover:[14]

> This is the first time an effort has been made by the united community to this end. The success of this effort is of paramount importance, not only for our immediate needs but the possibilities it opens for the future.
>
> The intensity of the speculative boom on this occasion was, in my view, as great as or greater than any of our major manias before. The intensity of the slump has been greatly diminished by the efforts that have been made. . . . We have succeeded in maintaining confidence and courage. We have avoided monetary panic and credit stringency. Those dangers are behind us. From the moment of the crash, interest rates have steadily decreased and capital has become steadily more abundant. Our investment markets have absorbed over two billions of new securities since the crash. There has been no significant bank or industrial failure. That danger, too, is safely behind us.
>
> The acceleration of construction programs has been successful beyond our hopes. The great utilities, the railways, and the large manufacturers have responded courageously. The Federal Government has not only expedited its current works, but Congress has authorized further expenditures. The governors, mayors, and other authorities have everywhere been doing their full part. The result has been the placing of contracts of this character to the value of about $500,000,000 during the first four months of 1930, or nearly three times the amount brought into being in the corresponding four months of the last great depression of eight years ago. All of which contributes not only to direct employment, but also a long train of jobs in the material and transportation industries.

The Department of Commerce has since reported that contracts emanating from railways, utilities, and public works during the first eight months of 1930 amounted to $4,500,000,000 as compared with $4,000,000,000 for the same period of 1929, a boom year. Not content with this, Mr. Hoover, in October, named a committee with Col. Arthur Woods as chairman to gather information on all the aspects of unemployment and to influence further alleviation.

STABILIZATION OF EMPLOYMENT

In August the United States index of factory employment was 79.9 as against 98.6 a year ago. The Federal Reserve Board's index for factory employment was 83.8 as compared with 103.4 a year ago. Total unemployment in the United States has been variously estimated as being between 2,500,000 and 4,500,000. Normal unemployment is from 750,000 to 1,500,000. Whatever the unemployment may have been, many families have been distressed and every one is the poorer. Out of the experiments[15] and discussions has, at least, come a general recognition that better stabilization is essential to the well-being of all mankind.

Technological unemployment has received much blame, but on the other hand many data have merged to indicate that it is not the major difficulty. The 1930 Y.M.C.A. conference at Silver Bay was informed that many companies were placing all employees whose jobs were being eliminated by improved machinery. One company even postponed the installation of such machinery until it could take care of the employees involved. There is evidence that equipment displacement affects the unskilled much more than the skilled, and it is claimed that there

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[14] *Nation's Business*, May, 1930.

[15] See *American Machinist*, July 24 and 31 and August 7, 1930; describing the methods of the B.&O.R.R. in the Mt. Clare shops at Baltimore, Md.

were not enough skilled mechanics at the worst of the unemployment. In the printing industry, a highly mechanized field, employing one-twentieth of all labor in American manufacturing, a study has been made by Elizabeth F. Baker, of the Columbia University's Council of Research. In this study unemployment cases due to mergers, labor turnover, and migration, that is, not to machinery improvement, were isolated. The remaining cases showed definitely that "skilled labor, so far from being displaced, is actually in greater demand because of the introduction of automatic mechanism. It is unskilled labor that suffers chiefly in the form of assistants or feeders, and they have a chance of improving their condition if not too old or too unambitious. Even displacement of unskilled feeders is smaller than might be expected—an average of 6.7 per cent in thirty-six plants in a period of five years."

In other words, if the facts are taken over a period of years, regardless of individual and temporary situations, improved machinery has made more work. Over a twenty-year period, employment has increased 40 per cent as compared with a population increase of 32 per cent. Since 1909 the income of wage earners in the United States has risen from thirty billion a year to ninety billion.

As a temporary solution to meet the assembly of unemployed in large cities, civic bureaus have been established to act as clearing houses. State laws are being framed for unemployment insurance, and some companies, such as General Electric and the Dennison Manufacturing Company, are going ahead without waiting for their state governments.

A survey made by E. S. Smith, of the Committee to Study Methods of Reducing Seasonal Business Slumps, indicated that 200 separate companies had started some sort of plan to meet this situation. Some leading companies, particularly the Procter & Gamble Company, have guaranteed employment under certain conditions, and much interest is being shown by other companies.

Organized labor has raised objections to the legislative solution for fear that state pensions may eventually tend toward dole systems and lessen the pressure on employers to solve the problem more constructively. As they point out, the true solution of unemployment is employment.

While a few companies have lengthened the working day in order to pay the same daily wage, in general, hours have been shortened and the five-day week has been given greater trial than ever before. In 48 national and international unions there are 532,894 employees on this basis. New York State leads with 185,000 employees.

Organized Labor

The attitude of the A. F. of L. may be summed up in its official pronouncement, made at the last annual convention:

> We hold that the best interests of wage earners, as well as the whole social group, are served by increasing production in quality as well as quantity, by high wage standards which assure sustained purchasing power to workers, and, therefore, higher national standards for the environment in which they live and the means to enjoy cultural opportunities. We declare that wage reductions produce industrial and social unrest, and that low wages are not conducive to low production costs.
>
> We urge upon wage earners everywhere that we oppose all reduction and that we urge upon the management the elimination of wastes in production in order that selling prices may be lower and wages higher.

William Green points out that 5,000,000 families in the United States are today living below the minimum standard of health and efficiency which he thinks $2400 a year can allow. He says further that 4,500,000 more families have barely enough to preserve life. If these 9,500,000 families or 33,000,000 people could have a margin for voluntary purchase, to say nothing of others who lack ordinary luxuries, it would go far toward overcoming the problem of overproduction.

On another angle, A. L. Berheimer, Director of the Labor Bureau, Inc., says, "The only feasible attack on technological unemployment is to attempt to narrow as much as possible the lag between discharge and employment. . . . This means not fighting the machine but controlling its rate of introduction and, in addition, timing its introduction."

Trade Associations

There has been a rapid growth of trade associations, or trade institutes as they are generally known. In the public mind, they are sometimes regarded as primarily price-fixing bodies which by some legal subterfuge have gotten around the Sherman Act and the Clayton Act. Nothing could be further from the truth. All their activities are conducted in strict accordance with the law, and any standardization of prices that may obtain throughout the various units of an industry is an incident rather than an aim. Standardization of prices follows very naturally from standardization of articles manufactured and the adoption of standard cost-keeping systems.

Trade institutes operate by standardizing commodities, methods, merchandising systems, etc. Those industries in which they have been established have eliminated the destructive cut-throat competition which has profited no one—not even the consumer—and injured many in the past. Trade institutes are a distinct function of management, because they are run by the executive managements of the units of the industry composing them. For instance, the National Association of Manufacturers is now working on a constructive program to stabilize employment. The New England Council is sending out six sets of questions[16] which are searching. The answers should be most illuminating.

Ethics

Ethical business codes developed in cooperation with the United States Department of Commerce and manufacturers' associations have been widely accepted. Leading employers are showing a disposition to consider the effects of their decisions on employees and the public at large.

Conclusion

If the business cycle may be epitomized by dividing it into stages of confidence, doubt, fear, and hope, then we believe we are well into the fourth stage of the cycle. Management has been challenged as never before. It has at least exerted itself, and, we believe, with some success. On the other hand, much remains to be accomplished. As W. L. Churchill says:

> The science of management indicates very limited development on the whole. Apparently there is more general acceptance of some of the earlier-developed factors of scientific management in industries that have been very backward and even reactionary in their application.
>
> Summed up, it appears as if we have paused in our progress in management and are consolidating our facts, experience, and findings preparatory for a definite and great forward movement. Management has a large task ahead. The large proportion of business enterprises reporting deficits and meager earnings points a need for much greater progress in managerial science.
>
> We still depend too much upon finding exceptional human talent and too little upon the science of management to insure success of our enterprises.

CHARLES W. LYTLE, *Chairman.*

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[16] *American Machinist*, October 2, 9, 1930.

Progress in Fuel Utilization in 1930

Contributed by the Fuels Division

Executive Committee: John Van Brunt, *Chairman*, A. D. Blake, *Secretary*, C. P. Tolman, S. B. Ely, W. J. Wohlenberg, and F. M. Van Deventer

IN SPITE of the widespread decrease in industrial activity during the past year, there has been no deceleration of progress in the field of fuel utilization. On the contrary, the necessity of reducing expenditures has brought to the attention of many executives the possibility and desirability of economies which might be effected by the proper utilization of fuels. The result has been a general improvement in the operation of existing equipment. New equipment which has been installed is noteworthy, not so much for any radical innovations as for the simplification and increased reliability of present methods. This, too, may be attributed to the desire to reduce expenditures to a minimum.

In all fields of fuel utilization the average efficiency is still far less than the maximum so far attained. While figures for this year are not yet available, it is believed that they will indicate a decided decrease in the spread between the average and best efficiencies. This represents greater progress than the attainment of efficiencies higher than present best operation in a few individual plants.

Production of Solid Fuels

Bituminous Coal. The production of bituminous coal during 1930 has been at a lower rate than at any time in the past five years, but due to the marked decrease in consumption the supply has been in excess of requirements. From the standpoint of the coal industry the situation is very unsatisfactory. With the coal output for the first 208 days of 1930 about 40 million tons less than for the corresponding period of 1929, it is still in excess of requirements by an amount estimated at one million tons per week.

The annual production and estimated capacity for 1920 to 1929, inclusive, and production to August 30 for the years 1926 to 1930, are given in Table 1.

TABLE 1 PRODUCTION OF BITUMINOUS COAL

(Millions of net tons)

Year	Production	Production to August 30	Estimated capacity, 280 days
1920	569	...	725
1921	416	...	781
1922	422	...	832
1923	565	...	885
1924	484	...	792
1925	520	...	748
1926	573	358	747
1927	518	348	759
1928	501	314	691
1929	532	340	...
1930	...	301	...

The past year has been notable for the increase in mechanization of mines.*[1,2] Continued low prices and decreased demand have brought about additional efforts to reduce production costs and increase recovery, with the result that the total tonnage mechanically mined has increased from 10,022,000 tons in 1926 to 37,862,000 tons in 1929.

Increasing attention is being given to the preparation of coal, especially to its cleaning, partly because of the greater use of mechanical loaders and partly because of the demands of important groups of consumers. The tonnage of coal cleaned in 1929 showed an increase of 29 per cent over that of the previous year.

There have been no outstanding developments in the bituminous-mine labor situation during the past year. Some changes in wage scales have been made locally, but there have been no stoppages of work except at a few individual mines. However, decreased markets for coal, low prices, and short working time, with certain wage reductions, have combined to bring about a feeling of unrest in mine labor which may possibly cause trouble in the coming year. Increased demand for coal which may be expected within the next few months will probably bring about greater stabilization in the industry and will improve labor conditions, but the situation is not considered satisfactory at the present time.

Prices of bituminous coal during the past year have been abnormally low. Large tonnages of coal have been sold at prices below the cost of production, and as a consequence the industry is in serious shape financially. There are some indications of improvement, but it is believed that it will take a long period of fair prices to make up for the losses which have already been sustained.

Anthracite Coal. The anthracite industry has taken a new lease on life and is doing much to bring back its old customers and secure new ones. Stronger competition of other fuels and the consumer's demand for cleaner, better-prepared coal have aroused the industry to the necessity of higher standards. Efforts have been directed toward the installation of new and more efficient equipment, better preparation, increased sales and engineering services, and extensive research, all of which are convincing evidence of a desire and will to place the entire industry on a higher plane of operating and sales efficiency.

Production of anthracite was slightly lower in 1929 than in 1928. For the first seven months of 1930 it was somewhat lower than for the corresponding period of 1929. Prices have remained at about the same levels as in the year previous.

Perhaps the most important event in the anthracite industry during the past year has been the execution of a new five-year agreement between the operators and the United Mine Workers of America, which, it is expected, will insure freedom from labor troubles during the period covered.

A development which may have a decided effect on anthracite sizing and preparation, and probably upon the price of the various sizes, is the rapid adoption of the automatic stoker for house heating, with a consequent increase in demand for the smaller sizes of coal.

Coke. Since last October the production of coke has shown a fairly steady decrease reflecting the decreased activity in the iron and steel industry. The total production of 58,000,000 net tons for the period September 1, 1928, to August 31, 1929, decreased to 54,000,000 for the corresponding period just passed. Beehive-coke production is at the lowest point in the history of the industry, amounting at the present time to only 4.5 per cent of the total.

* Numbered references in the text relate to the bibliography at the end of the report.

There has been a decided trend toward more careful selection and preparation of coals for carbonization. Not only have the carbonization industries demanded and obtained cleaner coal from the producers, but some of them have installed their own washing equipment. It has been reported recently that the largest by-product coking plant in the world, that of the Carnegie Steel Company, at Clairton, Pennsylvania, is to be equipped with the largest coal-cleaning plant in the world, having a daily capacity of 12,000 tons.

Fieldner[3] states that the elimination of mineral impurities from coal by washing results in a reduction of ash and sulphur in the coke, less clinker trouble, fewer cross-fractures in the coke, with a consequent reduction in breeze formation and greater uniformity in chemical composition and physical properties of the coke. The yield of gas and by-products per ton of dry coal charged is increased, and the sulphur in the gas is decreased.[4] On the other hand, there are deleterious effects resulting from the increased moisture content of the coal as charged, chief of which are reduction of oven capacity and throughput and higher fuel consumption.

Fischer[4] is experimenting on the carbonization of coals at pressures of about fifty atmospheres. He has developed a process on a semi-commercial scale with which he can produce a strong, dense coke from high-oxygen coals usually described as non-coking. The necessary pressure is obtained without mechanical means by restricting the escape of the gas.

Fuel Briquets. Some progress has been made during the year in the production of fuel briquets. The total output in 1929 was 1,212,415 net tons, an increase of 28 per cent over the previous year.[5] At the close of 1929 there were 25 plants in operation, the largest having an output of 200,000 tons per year. Of the fuels briquetted, 34 per cent were anthracite or semi-anthracite, 60 per cent semi-bituminous or bituminous, and 6 per cent semi-coke or carbon residue from oil-gas manufacture. The United States production of fuel briquets is only about 2 per cent of the world production. Germany produces about 80 per cent of the total.

An investigation[6] has been made of the briquetting properties of various coal slacks with the object of eliminating, if possible, the use of a binder. It was found that anthracite coal and semi-bituminous could not be briquetted with heat and pressure alone, even though pressures as high as 42,500 lb. per sq. in. were used. Semi-bituminous coals of high volatile content and bituminous coals can be briquetted without the use of a binder if the operation is carried out at the plastic temperature of the coal.

Petroleum Production

Considerable progress has been made during the past months in the curtailment of crude production, and the situation appears to be somewhat better than it was a year ago. Although the reduction in stocks has not been great compared to the total amount in storage, the fact that production has been decreased to a point where withdrawal from stocks is possible, is important in that it shows a trend in the right direction.

Despite the decrease in the production of crude, conditions are still far from satisfactory. Although the consumption of petroleum products has shown a reasonable increase during the past year, the stocks of gasoline have increased, and this has resulted not only in low prices of gasoline but it has also unsettled the crude-oil market. The fact that developed fields are capable of producing far more crude than the market requires, and the uncertainty of continued proration, are factors contributing to the instability of the situation.

Petroleum Refining

The most recent development in the field of petroleum refining is the starting up of the 5000-barrel-per-day hydrogenation plant at the Bayway Refinery of the Standard Oil Company of New Jersey.[7]

Refining processes in general have shown a marked improvement over the previous year. Due partially to improved fractionation and partially to a gain in cracking activity, the percentage of gasoline produced from crude increased from 37.4 per cent in 1928 to 39.3 per cent in 1929. The replacement of obsolete batch-shell stills with continuous-tube stills has continued and has resulted in decreased fuel consumption and improved products. The capacity of individual units has been increased, and at the present time units capable of processing 15,000 barrels of crude oil per day are in operation.[8] Automatic control of refinery equipment is becoming more widespread, having demonstrated its ability to improve uniformity of operation and of product.[9,10]

A recent innovation in the transportation of refined products is the construction of pipe lines for carrying gasoline. A 500-mile line with a capacity of 15,000 barrels per day is being laid from Marcus Hook to Cleveland, and another is to connect refineries in Oklahoma and Kansas with the Chicago-Milwaukee district.[11,12]

Gaseous Fuels

In the manufacture and distribution of gaseous fuels, the past year has been made conspicuous by two outstanding developments which have tended to be national in scope.

First of these developments is the discovery of tremendous natural-gas reserves, which has given rise to the transportation of gas over distances which several years ago seemed impossible. A line is now in operation from the Louisiana Monroe field to Memphis, Tennessee, and Atlanta, Georgia, and another from the Monroe field to St. Louis. The Texas Panhandle is supplying gas to Denver, and San Francisco is being furnished with gas from the Kettlemann Hill fields. Various lines are under construction with Chicago, Indianapolis, Minneapolis, and many other intervening cities as objectives. In the East, lines are proposed from West Virginia to Philadelphia, and an abandoned oil line from Olean, New York, to the seaboard has already been converted to transport gas to New York City. With the completion of the various proposed lines, natural gas will be available in every state with the exception of the New England and the North Pacific states.[13–17]

The second major development in the gas industry is the enormous increase in the production and use of liquefied petroleum gases. They are being used as domestic fuel in isolated homes; to replace gas oil for enriching water gas; as a base material for manufactured gas; for the recarburetion of gases to offset the loss of thermal value in high-pressure transmission systems; to meet peak-load conditions and as a protection against interruptions in service; as a source of gas supply to communities which are not large enough to warrant the installation of manufactured-gas plants; and for industrial heating purposes.

The production of liquefied petroleum gases increased from 4,500,000 gal. in 1928 to 9,900,000 gal. in 1929, with an even greater increase predicted for 1930. The number of individual customers served with "bottled gas" increased from 20,000 in 1928 to 55,000 in 1929. The first gas plant employing the butane-air carburetion process began operations at Linton, Indiana, in June, 1928. At the close of 1929, eight plants were operating, and at the end of May, 1930, twenty more plants were either operating or under construction.[18–23]

Manufactured Gas

Due to national economic conditions and also to the rapid development in the use of natural-gas and liquefied-gas fuels, there has been little development in the manufactured-gas in-

dustry during the past year. The percentage of manufactured gas made by the coal-gas process has continued to increase, while there has been a further decrease in the amount made by the water-gas process. The use of manufactured gas for house heating has accelerated at a more rapid rate than in any other field, although constant gains are being shown in both domestic and industrial fields.

The gas industry has displayed considerable interest in the possibility of utilizing refinery gases produced during the distilling and cracking operations. It is estimated that the production of refinery gas in 1930 will be over 545 billion cubic feet, more than the country's entire production of manufactured gas. Several gas companies have arranged to purchase refinery gas from nearby refineries under terms advantageous to both parties. The extent to which this factor will influence the future of the manufactured-gas industry is hard to estimate.[24-27]

An innovation in the manufacture of carbureted water gas is the use of Bunker "C" fuel oil instead of gas oil. Several companies have reported using fuel oil for this purpose with satisfactory results.[28,29]

The transportation of gas over long distances, not only natural gas but also manufactured gas, has been accelerated by improvements in the manufacture of steel pipe. Larger sizes are being produced, and longer lengths, and decreases in the weight have been effected.

Low-Temperature Carbonization

There has been little activity in the field of low-temperature carbonization. The plants now in operation are all on an experimental basis, the only large commercially operated plant in this country having been shut down early in the year. It is reported that a 600-ton-per-day plant using the Lomax process has been constructed at Chicago by the Prestcoke Corporation, but details are not available.[30] The Illingworth Company, which has plants under construction in Italy and France, is expecting to start construction of a plant in America within the next six or eight months.

The future of low-temperature carbonization in this country has been adversely affected by several factors. Among these are the improved quality of anthracite and more efficient selling methods, the increased output of high-temperature coke available for domestic use, and the successful introduction of small stokers. The shutdown of the New Brunswick plant has had a deterrent effect, while the exaggerated claims and statements of inventors and promoters of various processes have hindered, rather than helped, the development of the process.

Boilers

The trend toward higher steam pressures and temperatures continues not only in public-utility plants but also in industrial plants.[31] Boiler manufacturers are in a position to erect commercial units supplying steam up to 1800 lb. per sq. in. and 850 deg. fahr. total temperature. A boiler of the series type suitable for delivering steam at 3500 lb. pressure is being completed by the Babcock & Wilcox Company, and is to be given to Purdue University for experimental work. An experimental and special form of superheater installed at the Detroit Edison Company has operated successfully for some time delivering steam at practically 1200 deg. fahr.

Results of six years' operation of the mercury boiler at Hartford have been recently published.[32] Because of the low fuel consumption of 0.7 lb. per kw-hr. obtained, it is estimated that the excess investment over the cost of a steam plant should be wiped out in about three and a half years. The operation of the Hartford installation over the six-year period is reported as entirely satisfactory.

Boilers of the Löffler, Benson, and Atmos types continue to arouse considerable interest in Europe, where they have passed beyond the experimental stage. The existing installations are of relatively small capacity, however. Unless they can be successfully developed to provide for large capacity, there is little chance that they will become popular in this country.[33-38]

Boiler Furnaces

The many novel ideas in boiler-furnace design which have been incorporated in the past few years have received exhaustive tests in commercial operation.[39-41] The wealth of combustion data thus accumulated has served to eliminate unnecessary refinements, and at the present moment the designing of a furnace to burn a specified range of fuels does not require much guesswork. The early enthusiasm over the performance of furnace water walls has been somewhat tempered, and an economical limit for their use has been found in moderate- and small-size boilers operating under certain restricted conditions. The possibility of much closer estimates of furnace performance has had a beneficial effect on stabilizing certain types of furnace construction most suited for the fuel range in question, and has given a new lease of life to certain designs, for instance, to air-cooled refractory walls.

Besides the collection of practical operating data, some theoretical work on radiant-heat absorption and combustion in furnaces has been in progress, and the time is not far distant when the designers of water-cooled furnaces will be able to predict the performance under specified conditions with a reasonable degree of precision.

Quite noticeable has been the spread among engineers of a better understanding of boiler-furnace phenomena. The first slagging furnaces for powdered coal developed troubles due to gradual expansion of the refractory-lined bottom, but satisfactory constructions have now been achieved, and this type of furnace is fast becoming a favorite.

A recent installation at the State Line generating station has overcome the difficulty of slag penetration by the use of a water-cooled floor construction, with a hearth of magnesite ore. Water-cooled reverberatory arches have been installed extending across the upper part of the furnace in order to insure temperatures sufficiently high for the fusion of high-melting-point slags, while at the same time providing for cooling of the gases and chilling of entrained slag particles before they reach the surface of the boiler proper.

Combustion in Stoker-Fired Boilers

Considerable improvement in the combustion conditions with stoker-fired boilers has been attained by means of judiciously proportioned water-cooled protecting walls and arches. Simultaneously the air-cooled and sectionally supported refractory walls have amply justified expectations in many cases. Notable progress has been made in the rate of firing per boiler unit. The record-breaking performance of the new boilers at East River Station of the New York Edison Company is due mostly to the excellent functioning of the fin-tube furnace of 39,000 cu. ft. volume, where up to 75 tons of powdered coal have been burned per hour.

Regarding the furnace envelope in a broad way, it may be stated that a variety of air- and water-cooled elements have been developed and perfected which offer the possibility of selecting the most economical type for a wide range of fuels and for different types and rates of firing, and every variety has its particular use. The heretofore separate entities: the furnace, water walls, and the boiler, with the attendant maze of risers and downcomers, have been gradually merged into a simpler whole which may be truly called a steam generator. Among these

should be mentioned the compounded boilers with their water-cooled furnace envelope forming an independent radiant-heat boiler.

The flexibility of modern furnace design allows remarkable concentrations of steaming power within restricted floor space, as exemplified by the new boilers at the Kips Bay Station of the New York Steam Corporation. A further development is illustrated by a furnace which has been recently installed at the Lakeside station of the Milwaukee Electric Railway and Light Company. This furnace, which is part of a 1390-lb. boiler unit, has two sides cooled by high-pressure steam passing through 2-in. tubes.

STOKERS

The problem of smoke and dust abatement has given a new impetus to the development of stokers. In Europe, where the smoke and dust regulations are more strict, the activity in the use of stokers, even for the largest boilers, has been striking. Battersea Station (London) and West End Station (Berlin), which have adopted the American underfeed type, are the outstanding examples of this rather unexpected turn.

Great efforts have been made to perfect the details and increase the capacity of mechanical stokers. The steam, hydraulic, and electrohydraulic drives introduced in the last year are lending themselves better to the highly developed automatic combustion control. The movement of fuel in the underfeed types is now subject to a closer adjustment, and new forms of tuyères for preheated air have been developed. The use of larger stokers has resulted in problems of automatic control of air to the various sections of the stoker. An installation of the Detroit Edison Company designed to control the flow of air to a stoker 57 tuyères long by 14 retorts wide is reported to have given satisfactory results.

The largest underfeed stokers ordered recently for boilers of 500,000 lb. steam per hour capacity are 69 tuyères long and 15 retorts wide, with a fuel-bed area of 694 sq. ft.[42] Chain-grate stokers have reached widths up to 23.5 ft. The improved grating allows greater preheating of air and more even and complete combustion of poorer-grade coals. However, their progress is much slower than that of the underfeed type.

Traveling-grate stokers continue to be favored for installations burning anthracite, lignite, coke breeze, and free-burning coals, although it is stated that waste fuels such as bark, wood waste, and coke breeze can be handled successfully with underfeed stokers.[43]

There has been a great increase in activity in the small-stoker field, due probably to improvements in the equipment offered by various manufacturers. Changes have been made which give greater flexibility and more positive control of the motion of the fuel.

Although no new radical departures in the mode of stoker firing have been introduced during the past year, the relentless work of perfecting details has brought about conditions in which the stokers are economically on a par with powdered coal, and the considerable lag of stokers in operating flexibility has been largely overcome.

PULVERIZED FUEL

During the past year the art of burning pulverized coal has continued to settle down to sound engineering practice. There have been no new outstanding developments, efforts being exerted principally toward establishing good practice and simplifying designs.[44-48]

Powdered coal is now applied successfully for all classes of service and to all sizes of units. It is especially well adapted to very large steam-generating units for which proper stoker equipment would be difficult to design. Units generating over a million and a quarter pounds of steam per hour have been in successful operation nearly a year, and still larger units are under consideration. There seems to be no limit to the size of unit which can be easily fired with pulverized coal. In the small-size units, successful installations of powdered-coal firing are being made on boilers of sizes as small as 100 boiler hp. Pulverized coal continues to find favor for firing industrial furnaces of various types.

The direct-firing system is steadily gaining popularity, although there are still many engineers who prefer the storage system. Some data on the relative performances of the two types of units have been published, and the recent installation at the Deepwater station on the Delaware River, which has both bin and unit systems, will offer an excellent opportunity for comparison of the two systems under practically identical conditions. The total boiler horsepower installed or contracted for during the past year was considerably higher for the direct-fired than for the bin system.

When direct firing was first applied to steam boilers it was thought that the high-speed type of mill was best suited for the system because of its compactness, but some recent installations using the roller and ball types of mill have been very successful. Recent progress in mills has been almost entirely toward improvement of existing types by making them more efficient, more reliable, and better suited for long periods of operation. Progress has also been made in the development of the designs for high capacities. Mills are now available for capacities up to 40 tons of coal per hour.

BURNER DESIGN

The tendency in the design of burners is toward simplicity and low cost. This tendency has been greatly stimulated by the present business depression and close competition. It may be said, however, that in general the simplicity has not been obtained by a reduction in efficiency. In fact, in some cases simplicity is being obtained with an improvement, an indication of real progress.

As pointed out in last year's report, there are three general methods of firing pulverized coal, namely, vertical, horizontal, and tangential firing. The horizontal method of firing, on account of its simplicity and ease of installation, is now receiving the widest application. It is used on most of the smaller units, and to a considerable extent on large units.

Although in general all of the air for combustion is supplied under pressure, burners designed for natural draft are in successful operation. The only air supplied under pressure is that furnished with the coal by the pulverizer fan.

Burners intended for a variety of fuels have been improved during the past year. They are available for large capacities and are exceedingly flexible in their operation.

FURNACES FOR PULVERIZED COAL

Furnaces used for pulverized-coal combustion have already been discussed. The previously hoped-for high rates of combustion have not materialized. At present good engineering practice is to design furnaces for rates of continuous heat liberation not exceeding 20,000 B.t.u. per cubic foot per hour with refractory walls, and 30,000 B.t.u. per cubic foot per hour with water walls.

There is a growing sentiment against the discharge of ash and cinders from stacks and boiler plants. Black smoke resulting from incomplete combustion has been practically eliminated. Attention is now being given to the solids which are carried by the gases into the atmosphere. While pulverized-coal stacks are not the only offenders in this respect, it is generally realized that

they contribute to the nuisance, and efforts are being exerted to develop an effective and inexpensive means of removing flue dust from the gases before they are discharged into the atmosphere.

DUST REMOVAL FROM GASES

Developments to remove the dust from the gases have been carried along three principal lines, namely, electrostatic precipitation, mechanical separation by means of cyclones, and washing with water sprays. In the United States the removal of dust by electrostatic precipitation has received the widest application. Several large central stations are now using this method successfully, and there are indications that it removes over 90 per cent of the dust in the gases. The cost of installation varies with the size of the plant. In large central stations this cost is $2 to $3 per kilowatt of capacity, but for smaller plants the cost of installation may reach $5 or even $7. The energy required for the operation of the apparatus amounts to 0.03 or 0.04 of one per cent of the output of the plant.

The dry mechanical method of dust removal has been applied to several smaller plants. It is said that about 75 per cent of the dust is removed by this method. The dust remaining in the gases is very fine, and is carried a long distance from the plant and does not constitute an acute nuisance.

The removal of dust by water sprays has been applied in a number of installations abroad, and in one or two instances in this country. When properly applied, good results are claimed for it. There is no doubt that in the near future there will be much activity in the development of simple and inexpensive means of removal of dust and cinders from stack gases. The public demands it, and from an engineering standpoint a solution of this problem is possible.

Automatic-control equipment for pulverized-fuel firing is becoming more dependable and less costly. Some recent installations have demonstrated a remarkable ability to control combustion conditions and steam pressures with widely fluctuating loads.

FUEL-OIL AND GAS BURNERS

The great increase in the consumption of natural gas, most of which is used for industrial purposes, has led to improvements in gas burners. Inasmuch as the gas is frequently burned in conjunction with fuel oil or pulverized fuel, the fuel used at any time depending on the market, more attention has been paid to combination burners which will handle gaseous, liquid, or pulverized solid fuel. At the present time burners are available which will handle either gas, oil, or coal at rates of heat liberation of over 100 million B.t.u. per hour. In some installations these burners have been used successfully with air preheated up to 900 deg. fahr. The use of gas or oil as a stand-by fuel is popular, and under these conditions the burners must be exceedingly flexible in their operation. A recent installation provides for a change from practically no load to full load in 40 seconds.

At the new electric station of the Louisiana Steam Products Company, refinery sludge is being burned with mechanical-atomizing burners. This is the first time that this has been done successfully with such burners. At the same plant the combination burners are handling natural gas, fuel oil, and petroleum coke.

GAS PRODUCERS

Although the size of gas producers has remained unchanged for the past twenty years, most of them being from 8 to 11 ft. inside diameter, the capacity per square foot has steadily increased, and the quantity of steam required in the air blast to prevent clinkers has steadily decreased. The amount of hand poking required to condition the firebed has also decreased.

During the past year capacities up to 70 lb. of coal per sq. ft. per hour have been maintained using a fair grade of coal, and 65 lb. of coal per hour per sq. ft. using an inferior coal having an ash which fused at 2080 deg. fahr. These advances have been due to a more uniform distribution of the fuel and air blast, a more uniform removal of the ashes, and a somewhat more rapid mechanical agitation.

The adoption of water-jacketed walls for gas producers during the past year has greatly reduced the need for hand poking and has cut down the steam required in the blast to 20 per cent or less of the weight of coal.

An automatic control for gas producers has been placed on the market in which slight variations in temperature from a predetermined normal are utilized to vary the rate of coal feed, which in turn brings the temperature back to the desired point. W. B. Chapman has been experimenting independently for the past few years with a new type of producer for gasifying slack coal at high rates, and has obtained a satisfactory gas while operating at a rate of over 150 lb. of coal per sq. ft. per hour.

INDUSTRIAL FURNACES AND POWER PLANTS

Industrial furnaces and power plants have shown marked improvements during the past year. The more modern industrial steam-generating units are in some cases ahead of central-station installations, in contrast with former years when central stations were depended upon to blaze the trail in new developments. The use of high pressures has found favor in industrial plants, particularly where process steam is required. Two units which are to operate at 1350 lb. pressure with a maximum capacity of 700,000 lb. of steam per hour from each unit are now being erected for the Ford Motor Company. They will be the largest boilers in the world designed for so high an operating pressure.

Automatic control has proved successful even when the steam demand fluctuates over a wide range in short periods of time, as is frequently the case with industrial loads.[49]

Industrial-furnace design is frequently complicated by the necessity of handling various fuels which may be by-products of the process. In the steel industry the combined firing of blast-furnace gas and powdered coal has become quite common,[50] but the combined use of stokers and blast-furnace gas has not been successful.[51] Refinery sludge, asphalt, tar, petroleum coke, wood waste, and other by-products are being burned successfully in industrial plants with good efficiency.

FURNACE PROGRESS IN THE STEEL AND CERAMIC INDUSTRIES

In the steel industry progress has been made in the use of mixed coke-oven and blast-furnace gas for heating open-hearth and heating furnaces.[52,53] Automatic control of open-hearth furnaces has been successfully applied and will probably be extensively employed in the future.[54] The insulation of open-hearth furnaces has also been given greater consideration.[55,56] The trend in blast-furnace construction has been to increase the size of furnaces by increasing the hearth and bosh diameters, which has resulted in greater tonnages and a consequent lowering of the coke rate. Improved methods of screening coke, and automatic methods of weighing the charge and filling the furnaces, are being installed with the object of securing more regular operation.

In the ceramic industries the more progressive manufacturers are indicating an increasing desire to modernize their plants. Several brick manufacturers are trying different types of stokers in their kilns, and in some instances the outlook for this application of stokers is promising. With some stokers it is possible to fire kilns with lower grades of coal than have previously been used. Some railroad-car tunnel kilns are now being built to be

fired with stokers. The Bureau of Mines and Ohio State University, in cooperation with the brick and the tile industries, producers of fuel, and manufacturers of equipment, are conducing extended investigations on the use of fuel in brick kilns. The major portion of the work so far has been on the application of stokers, but plans for future work include studies of the types of furnaces used in kilns and a comparison of different types of coals, producer gas, fuel oil, natural gas, and pulverized fuel.

In the field of smaller furnaces much development work has been satisfactorily completed. Outstanding in the industry is a process for the bright annealing of metals which depends upon the maintenance of a special atmosphere within the furnace. A process has been devised for the continuous nitriding of steel which has proved to be a distinct improvement over the usual batch process. Continuous heating for forging has been successfully accomplished and has resulted in the saving of fuel and labor and greater uniformity of product. Furnaces have been constructed for the carburizing of steel parts in which the carburizing agent may be maintained at a pressure of two or three atmospheres. Other developments include improvements in the design of soaking pits, the introduction of a smelter burner which will give a long, adjustable flame, improvements in conveyor mechanisms, and the more general use of automatic control. Of particular importance also has been the study of flame luminosity and diffusion flames.

Marine Power Plants

The predominant fuel at present for the marine power plant is oil. The ease of bunkering and the possibility of storing the oil in ballast tanks without encroaching on cargo or passenger space give fuel oil a distinct advantage over coal and permit a greater differential in the respective prices than is possible in stationary practice. The development of pulverized fuel for marine use continues, however, and the number of such installations has now increased to twenty-one. The original installation was made in 1927 on the S.S. *Mercer*, which has now traveled over 100,000 miles without a single detention due to the use of pulverized fuel.

The tendency in this country is toward propulsion by steam rather than by internal-combustion engines. It is true that several large boats under foreign flags have been fitted with oil engines, but the two outstanding foreign vessels put in service during the year, namely, the *Europa* and the *Bremen*, are both steam-driven.

Higher steam pressures are coming into vogue, but no attempt has been made to adopt pressures of 1400 lb. or over now common in stationary practice. Two new tankers are just being completed which are equipped with boilers and superheaters supplying steam at 420 lb. pressure and 750 deg. fahr. These tankers will have the highest steam pressures and temperatures of any ships operating under the American flag. The installation made several years ago on the S.S. *King George V*, which uses 500-lb. steam, continues to be the highest-pressure installation ever attempted for marine use. Ultraconservatism on the part of marine engineers and the space limitations which militate against the bleeding and reheating used to effect economy in high-pressure shore plants, are the probable reasons for the more moderate pressures in marine use.

The system of employing an exhaust-steam turbine to augment the main drive power, which has become so popular in Europe, made its initial entrance into the United States marine field during the past year. This system promises an increased efficiency and also enables existing vessels to increase their speed without additional boiler capacity and without material increase in fuel consumption.

During the past year two new ferries for service on the Great Lakes were equipped with forced-draft chain-grate stokers. This is the first installation of the kind in the American merchant marine. A stoker with rotating crusher rolls for marine use has also been developed, and several installations have been made.

Domestic Heating

The year has witnessed increasing competition between anthracite, coke, bituminous coal, and oil and gas for domestic heating, both in the merchandising of the fuels themselves and in the sale of equipment for their application. There is an increasing tendency to retail solid fuels in forms better suited to the needs of the householder, both in the sizing of the fuel and in treating it so as to make it sufficiently dustless.

The sales of oil burners for the first half of the year, as reported by the Department of Commerce, show only a small increase over the same period for 1929, which may have been due to the general business depression rather than to the application of oil to domestic heating having reached its peak. The year has seen a remarkable increase in the application of domestic stokers both for small-size anthracite and for bituminous fuels. The bituminous trade seems to see in the application of stokers a means to offset the inroads which have been made by oil and gas. Many new makes of stokers have been put on the market, most of them using the underfeed principle and forced draft. There is an increasing tendency for the formation of associations for the benefit of merchandisers of fuels and of dealers in special branches of domestic equipment.

The Bureau of Mines reports that its Pittsburgh Experiment Station has been continuing its study of problems connected with the burning of fuels in domestic furnaces. Such studies give information on the relative burning characteristics of fuels which is essential to the proper utilization of the fuels in various types of equipment.

Research

There has been a notable increase in fuel research, both pure and commercial, during the past year. The United States Bureau of Mines is conducting investigations on more than thirty problems relating to the production or utilization of coal, and they are also doing considerable research on liquid and gaseous fuels. Other problems are being carried on by the various universities, with indications of increased activity in the future. The Carnegie Institute of Technology has recently announced a five-year program of coal research which has been made possible by the financial support of a number of great corporations. Commercial laboratories have not been remiss in contributing their share to the increasing store of knowledge, and the trade associations and professional societies have in some cases established research laboratories, in addition to their activities in cooperating with other research organizations and in disseminating available information. An enormous amount of fuel research work is being carried on abroad, particularly in Great Britain, Germany, and France.

The number of technical papers on fuels presented within the past year was probably greater than ever before. The subjects covered included almost every phase of fuel production, processing, and utilization. Two world-wide meetings were held at Tokyo and at Berlin, at both of which much attention was given to the subject of fuels.

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The appended bibliography of necessity does not include references to all the material covered in the report, since much of the information was supplied by those who cooperated in the compilation and is a result of personal experience rather than of published records.

T. A. MANGELSDORF.*

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Progress in Machine-Shop Practice

Contributed by the Machine Shop Practice Division

Executive Committee: W. J. Peets, *Chairman*, Carlos de Zafra, *Secretary*, K. H. Condit, W. W. Tangeman, J. W. Roe, and F. C. Spencer

DURING the period since the previous Progress Report of the Machine Shop Practice Division there has been continued development in machine tools, the materials from which the tools are built, and in the products which the latter are designed and constructed to machine.

Considerable economies have been effected in the substitution of pressed for cast-metal parts, and coincident with this the art of welding has been given impetus to speed its applications and development. Lightness, savings in materials and space and time, and other desiderata have resulted from the more general introduction of welding into machine-shop practice.

CHROMIUM PLATING

Chromium plating has been subjected to further research and new applications. From a protective coating to withstand the ravages of atmospheric conditions, as on automotive accessories, it has been developed into a protective coating for metal parts exposed to exceedingly high temperatures coincident with deteriorating gases and great friction, as in the plating of the rifling of cannon, heretofore all too quickly corroded by these factors. As yet too short a time has elapsed to draw any definite conclusions, but the indications are that the accuracy life of the guns now the subject of experimentation will be increased. These rather extreme conditions, if successfully met by chromium plating, may suggest further applications in industrial practice. Time will tell whether or not the difference between the expansion rates of gun steel and chromium will result in cracking and flaking off of the deposit, or whether such excellent cohesion has been attained as not to be thus affected. Very decided economies have resulted from the restoration of worn gages to their original sizes by chromium plating, as well as greater life, and similar treatment of twist drills has been found to prolong their utility.

TUNGSTEN CARBIDE CUTTING TOOLS

The use of tungsten carbide alloys for cutting tools has continued, with both favorable and unfavorable comment, depending upon the character of the cutting done and upon the further research and experience such applications have afforded. At first relatively light continuous cuts were made. During the past year the material has been employed in heavy machine-tool work. In certain shops tungsten carbide tools have been used

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on various types of work with success in some applications and failure in others. The failures in most cases, however, indicate rather a lack, as yet, of sufficient data than unserviceability of the alloy. Cuts are being made today that a year or so ago were regarded as beyond its scope. Much has yet to be learned, and the fact remains that the field is gradually broadening for this alloy as experience provides the data for progress. The failures, where they have been recorded and made available for the information of others, indicate in some instances a lack of information or data on the possibilities of tungsten carbide per se, while in other instances the machines used in the experiments were entirely unsuitable for the use of this alloy. It will be recalled by those who attended the machine-shop-practice session at the annual meeting in December, 1928, when the subject was there presented, that E. F. DuBrul, manager of the Machine Tool Builders' Association, strongly advocated a research fund of many thousands of dollars to expedite the development of data and provide the tool makers with definite knowledge upon which to redesign or build anew high-speed machine tools such as would afford the new cutting alloy opportunity to develop in practice its potential possibilities at an early date. It was likewise pointed out that even today machine tools built many years before the advent of high-speed steel are being used with tools made from that metal, thus preventing the most economic returns from a cutting material that is capable of a far greater output than the antiquated machine can possibly permit it to produce. It is still to be hoped that the suggested research fund will yet be forthcoming so that twenty-five years from now we shall not then see tungsten carbide cutting tools harnessed to these museum antiquities.

The constantly increasing degree to which precision measurements are being applied in mass production shows a healthy development of machine-shop-practice technique. Finer cuts and higher degrees of finish through the supplemental application of superfine abrasives have been the great contributing factor in this phase of "quantity precision," if such a phrase may be coined. Together with the foregoing has come the development of instruments for quantity-production measurements at a rate in keeping with the production schedules.

Coolants and Cutting Fluids

There seems to be considerable room for enlightenment on the subject of coolants and cutting oils or fluids. New products are on the market, and the introduction of higher cutting speeds introduces new problems not always satisfactorily met by old solutions. Request has already been filed with this Division for discussion on the subject, and sufficient interest has been indicated to warrant a symposium on cutting oils and coolants in the very near future.

The interior finishing of large cylindrical elements, such as locomotive and Diesel-engine cylinders, and of guns up to 16 in. caliber, has been progressed by the development of large-capacity honing machines.

The use of nitridation for the hardening of parts in process of manufacture has been extended in its applications. Its advantages are becoming more extensively appreciated, not only as to the saving in production costs which it effects, but with respect to the time taken as well. The fact that the process introduces no supplemental stresses which must be subsequently relieved is in itself perhaps its most commendable virtue.

Color in Machine Tools

Color has crept into the field of the machine during the past year, though not suddenly. We had an intimation of what might be expected in the generalization of color in household appliances. Today the housewife is favored with color effects to add cheer to the daily grind in kitchen, laundry, and cellar. If color has such a stimulating and psychological effect upon the home worker, why not apply it to the service of the technical worker as well? Some one has said that a variety in colors of broom handles may not necessarily promote the utilization of brooms, but that at least it compels the dealer to stock up with more brooms in order to offer a color selection to his trade. On the other hand, we can scarcely conceive of the machine-tool dealer stocking up with, say, a line of multiple-spindle machines, some in light blue, some in mauve, some in pink, and others in orange and green—surely a machine tool will be sold on performance and not on appearance; however, we must recognize certain influences as they develop. Today one does not see the sculptural embellishment that characterized the machine tools of a quarter-century ago. Present-day machines are built upon simple lines, yet one admires even simple lines when they are of pleasing and graceful contour. It appears now that a company in the Middle West is to build a five-acre one-story industrial plant devoid of skylights or windows, with artificial lighting superior to anything the sun can supply, and with an orange color scheme for its machinery to "increase their visibility." Surely there is little of an inspirational nature in the grim black of most machine-shop equipment, which in itself darkens the shop and renders it a sort of catch-all for dirt and grease. How much cleaner and more sanitary would be a machine shop in which light colors prevailed. Imagine, for instance, a shop equipped with machine-tools painted a cream color and striped in gold or light green. We have seen the engine rooms of olden times transformed by tiled walls and mosaic floors; we have seen the black foundry of the past made into a bright daylight workshop by the application of whitewash, and we shall see sooner or later the dark and dirty machine shop modernized by the application of light colors to our machine tools, colors which readily show up the dirt and which make it necessary for any self-respecting machine operator to keep his equipment polished up as he would his automobile. During 1931 we feel that there will be many contributions through the technical press and the professional meetings dealing with the subjects already referred to, as well as with others not touched upon, such as high-test cast iron, further applications of hydraulic feeds to machine tools, etc. There is much new material now being collected, which, when combined with the further experience of the coming year, will supplement with information of real merit our knowledge of machine-shop practice.

Interrelation of Fields of Management, Materials Handling and Machine-Shop Practice

The fields of management, materials handling, and of machine-shop practice are so interwoven that the progress recorded in the first two likewise constitutes progress in the third in so far as it applies to machine-shop practice. More and more interest is being evinced by machine-shop foremen and superintendents in the best solution of their respective problems, and it is to be noted that in the evening divisions of the technical schools and colleges, men holding these positions, as well as others of lesser rank, constitute a goodly number of those enrolled for courses leading to the same degree as those who pursue the same studies in the daytime. It speaks well for the future that the intelligence of the shop is on the increase. These men are among the most conscientious in their work, and are the most satisfactory to teach because they take their work seriously. And in their daytime work, those who are machinists and mechanics in general take more interest in their routine tasks, working always with a keener sense of what they are doing and being on the alert to do it better. Much is to be expected from these men, and such education will go a long way toward counteracting agitation by the ignorant.

Carlos de Zafra, *Secretary*.

Progress in Hydraulics

Contributed by the Hydraulic Division

Executive Committee: W. M. White, *Chairman*, B. E. White, *Secretary*, Ely C. Hutchinson, L. F. Moody, and E. M. Breed

WHILE appreciable progress has been made in hydraulic engineering during the past twelve months, it is proper to remark that there is little or nothing that is absolutely new to report in this field. The considerable progress which has been made is essentially along the line of the extension of principles and in the uses of equipment and methods which have been previously described.

Since water power constitutes a very large sector of the field of hydraulic engineering, the engineer has a more or less vital interest in the trends of those events which tend to accelerate or limit the development of additional power. It therefore seems proper to mention in this report the apparently growing tendency of the general public and of public officials to base their attitude toward and decision regarding these and related matters more and more upon economic rather than sentimental, esthetic, and political grounds.

In California, where water is the veritable life blood of civilization and progress, the state has entered upon a comprehensive scheme of allocation of the use of water to the various conflicting interests of power, navigation, irrigation, and domestic water supply. The sane administration of such allocation cannot help but be beneficial to all concerned, and if the experience in California is satisfactory, a wide extension of this principle may be expected throughout the United States.

The interconnection of large power systems, and the operation of larger and larger groups of power facilities as a unit under a single or unified management, is proceeding apace with no sign of limitation. Apparently the largest existing systems are still well within the economic limits of such combination and management.

Tendency Toward Larger Power Units

There is an unabated tendency toward larger and larger power units, and to the simplification of power stations and systems with a minimum number of units, with an avoidance of all possible complications and the use of automatic operation, load division between units, and automatic frequency control, all of which comparatively recent developments are being used with success at an accelerating rate. With the large aggregate capacity of generators in representative large systems, there is every reason to increase the size of units up to the largest physical dimensions and capacity possible consistent with the economic use of the available water supply. In most cases this justifies the installation of each unit with its auxiliaries and transformers as a single unit feeding a single transmission line, with simple means of cross-connection or interconnection between the lines and units on the high-tension side, all of which results in the utmost simplification in layout and equipment, as well as minimum cost of construction and maximum reliability and ease of operation.

Automatic hydraulic protective and regulatory devices are being multiplied and extended in their scope, including automatic shut-off valves for shutting off the flow of water in conduits under excess pressure or excess velocity, and for a variety of other purposes almost undreamed of only a short time ago.

Model Testing

Model testing has been going on at an accelerated pace during the past year, several notable laboratories having been constructed during that period, of which the Holtwood Laboratory of the Pennsylvania Water & Power Company is an outstanding example. The projected National Hydraulic Laboratory is now about to become a physical operating entity, charged with the duty of investigating the fundamentals of hydraulics and of pursuing hydraulic experiments at the request of the various Government departments. It seems probable that the management of this laboratory will work in close cooperation with the managements of various university and private hydraulic laboratories, and thus harmoniously and cooperatively promote the greatest and most rapid progress in hydraulic engineering through the means of model testing.

One or two cavitation laboratories have been established in the United States, essentially along the same lines as the European laboratories, in which excellent results have been obtained. It is interesting to note that by the use of light metals and fractional heads, it has been found possible at Karlsruhe, Germany, to duplicate correctly the cavitation results with full heads and full-size machines. Valuable results have been secured at the Shawinigan Falls, Que., and Holtwood laboratories under full-head conditions.

Research

Since the recently issued report of the Committee on Survey of Hydraulic Research of the Division, the following list of problems now under investigation in the hydraulic laboratory of the University of California has been received:

1 Action of waves on sea beaches and effectiveness of shore-protection structures. Studies by means of sectional and full models.

2 Velocity and manner of travel of salt water released through locks into fresh-water pools. Studies in cooperation with U. S. Engineers.

3 Operating characteristics of jet pump, using sectional models.

4 Operating characteristics of disk friction pumps.

Research during the past years has to a large extent been along economic lines, with a view to a reduction of losses and increase in life of hydraulic structures and machines. The continuation and extension of such research has been fostered also by the increasing willingness of purchasers of hydraulic and electrical equipment to evaluate reductions in losses when comparing and accepting bids.

Turbine Developments

The use of the Kaplan turbine has been extended both in America and abroad. During the year also hydraulic turbines of the largest physical dimensions and weight yet constructed have been built and installed, among them being the Spiers Falls, N. Y., unit of 57,000 hp. under 81 ft. head, having a 19-ft. 2-in. discharge opening, and weighing 140 tons, and the Dnie-

prostroy, Russia, units of 84,000 hp. under 116 ft. head, of 160 tons, and several units installed in Canada.

The use of runners in which pressed-steel vanes are welded between cast crown plates and seal rings has increased during the past year. Both babbitted and rubber-lined turbine guide bearings have been increasingly used during the past year and have practically become standard. The rubber-lined bearing is especially valuable with the axial-flow or propeller-type turbine, where the guide bearing is less accessible than with other types. Butterfly valves are being more and more used, particularly since recent developments have been made in sealing these valves against leakage, which was a drawback to this type. Successful experiments have recently been made in California in the use of butterfly valves as free-discharge valves. Butterfly valves have also been used in larger dimensions and under higher heads, notably those at the Pigeon River, N. C., development, operating under a head of 861 ft., which were constructed entirely of cast steel and are automatically operated.

The use of the axial-flow or propeller-type turbine has increased the speed of rotation and correspondingly reduced the cost of generators. The use of rolled steel and welding in generator construction is increasing more rapidly as time goes on, resulting in great economy in cost and speed of construction, as well as decreased weight. Each machine, in a sense, becomes special without increase in cost, except for the making of a few detail plans, thus resulting in real economy all around.

The umbrella type of generator is being more generally used and its vertical height has been still further reduced by installing the combined thrust and guide bearing within the lower generator bracket rather than on top of it.

The use of tungsten carbide tools has increased the speed of machining, while various developments and researches in the punching and machining of generator and turbine parts and the use of hydraulic pressure in coil forming, etc. have resulted in generators and other equipment having closer clearances and better efficiency being produced at less cost. Recent research has also resulted in better insulation materials and in the determination of the voltage conditions in generator coils which have a decided bearing on the possibility of utilizing higher generator voltages than the maximum of 13,800 volts now customary.

Steady progress is being made toward better designs for generators of the true outdoor type, which are especially adaptable to single-unit stations which are remote controlled, particularly in climates which are not too cold. In addition, there is a decided tendency toward closed generator ventilating systems in which the air is cooled and recirculated.

Regulation

The application of Selsyn motors for indicating devices and other operations in power plants is rapidly multiplying, as is also the use of telemetering in automatically controlled power stations. The use of oil as a governor medium is reported as becoming practically standard. Governors are being more and more installed in pairs, including pumps and other auxiliaries, either one of which can be used to operate two units, thus leaving power-house basement space available for other purposes.

The use of the automatic operator has been extended, and improvements and new devices in this field are continually coming on the market. In one station the actual efficiency is reported as being between $^1/_2$ per cent and $2^1/_2$ per cent less than the best theoretical efficiency, as compared with from 5 per cent to 10 per cent with excellent manual control.

Motor governor flyball drives are becoming much more popular on account of the quietness and certainty of their operation. By adding three slip rings to the pilot exciter, its voltage output is practically steady, and operation of the flyballs therefrom has become much more satisfactory.

Speed-matching devices for automatically synchronizing generators have been introduced and their use is rapidly increasing.

In Europe, the use of pumped-storage hydro plants is still rapidly increasing. There is a wide diversity of opinion as to their value under the conditions obtaining in the United States, and consequently the extension of this type of installation in America has not been as rapid as was anticipated by some.

The problem of dissipating the energy of large volumes of waste water has been solved for two widely different cases by widely different means. At the Arapuni, New Zealand, plant, jet dispersers which whirl into a harmless spray as much as 3000 c.f.s. of water delivered to it under a considerable head by a large conduit, have been installed. For the Safe Harbor, Pa., development, hydraulic-laboratory experiments have resulted in the development of an apron having an inclination of 26 deg. above the horizontal, with the piers between individual crest gates carried to the toe of the apron, which construction has been found to deliver the water in a spray at a distance far enough downstream to avoid all harm to the structure of the dam.

There has also been an extension of the practice of installing relief valves in combination with surge tanks, which has been found to materially reduce the required dimensions of the tanks, still giving equal regulation.

In regard to water conduits, the non-deforming penstock manifold is coming into greater use, this structure being statically determinate and at the same time affording good hydraulic conditions at the branch, or point of take-off.

Other Developments

New devices for obtaining power from the tides have been developed in Europe, and it is stated by competent authority that the development of power from this source appears to be an assured economic success.

The use of oil-engine power in competition with steam is also increasing, while in California the discovery of vast additional supplies of natural gas has resulted in still cheaper steam power than can be produced with other forms of fuel, including coal and oil. The economic conditions in the California area are now viewed as being quite similar to those in other vast sections of the United States and Canada, in that recurring droughts have made it evident that much greater reliance must be placed upon fuel-generated energy, and hence the bulk of the additional power supply for a considerable period in the future will probably be from new steam or internal-combustion-engined plants.

This situation is accentuated by the continual improvement in the economy and efficiency of steam power and the continued development of the better water-power sites, so that those remaining for future development become less and less attractive.

In the field of hydroelectric construction, the most conspicuous advance has been in the adaptation by the Germans of a chain-bucket excavator, which excavates a canal prism to exact shape. This device was successfully used in the River Shannon development in Ireland. An investigation was also made by one of the power companies of California of the economics of installation of longitudinal reinforcing steel versus the construction of efficient expansion joints in concrete flumes.

In conclusion, the author wishes to express his heartfelt thanks to Messrs. L. F. Harza, Ely C. Hutchinson, O. V. Kruse, Chester Lichtenberg, A. H. Markwart, C. A. Powel E. G. Rogers, R. E. B. Sharp, R. L. Thomas, William Monroe White, and I. A. Winter who were unselfish enough to each devote a considerable period of time to the preparation of worth while letters to him detailing the progress in this field as seen by them.

BYRON E. WHITE.

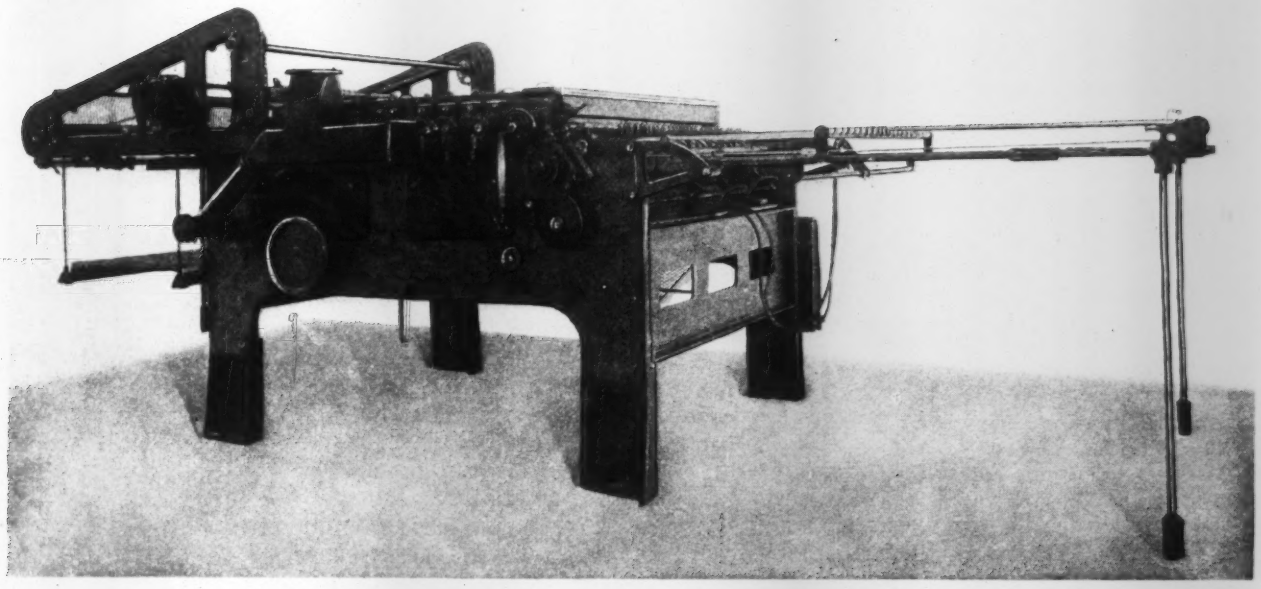


FIG. 1 FLAT BRONZING MACHINE, U.P.M.-KIDDER COMPANY, DOVER, N. H.

Progress in the Printing Industries

Contributed by the Printing Industries Division

Executive Committee: Edward Pierce Hulse, *Chairman*, J. W. Rockefeller, Jr., *Secretary*, J. C. Oswald, F. M. Feiker, G. C. Van Vechten, and W. C. Glass

THE Printing Industries Division, in presenting its report for 1930, feels there is much salient matter in it that will apply to activities in fields other than just printing. There have been several repercussions from papers read at the New York meeting of the Printing Industries Division, April 4, 1930. The one by Ortman, on "Plant Operation Without Alibis," invited favorable comments, not only because it applied to printing plants, but also to industry as a whole. Being a paper on what every head of an organization has too frequently to contend with, it sounded a vibrant note calling for fresh endeavor to overcome a fast-growing tendency to shift responsibility to others. In this sense it found a much wider application than to the specific field of printing, and awakened new interest in what to do successfully when encountering similar conditions.

There was also at this meeting an unusual presentation of three papers on production engineering and correlated subjects bearing on plant arrangement. These papers, coming from locations remote from each other, emphasized plant arrangement and control from three viewpoints, yet all were devoted to proper and systematic production. Today plants are built around a product and not the product adapted, often inexpeditiously, to a chance structure.

Much has been published on this phase as to power, steam, machinery and the like, and the papers mentioned amplify this by detailed description of plants where production must flow along the smoothest lines—for "on time" without qualification is a dominant factor, and this in continuity from many diverse sources, yet all required in proper sequence for the completed publication.

There is much in these papers that fits in well in structural and routing planning regardless of the type of manufacture, and the Printing Industries Division is endeavoring in its province to do what it can for the industrial field at large to broaden the concepts of orderly thinking and constructive arrangement in those things that must stand to the best advantage the test of time and insistent demand.

Gold has always held a popular appeal; it fills a place entirely its own, and in printing, bronzing has become an important operation in bringing out effects on the printed sheet that nothing else can do. While not confined to gold effects, as silver, aluminum, copper, and other bronze powders are in use, gilt work is in the greatest demand. Always a dusty job and not altogether a healthful one when done in the open, bronzing machines had been devised to overcome the aversion to bronzing. An early type had a large cylinder which carried the sheet beneath soft pads, spreading the powder over the work, and later types were provided with vacuum systems which reduced the spread of dust and conserved the powder.

The latest type of bronzing machine, as shown in Fig. 1, is a radical departure from the cylinder machine, being of the "flat" type wherein a sheet is carried along a straight path rather than circuitously through the cylinder machine. While flat machine bronzing had been attractive, the cylinder machine produced better work, and until the advent of this new machine

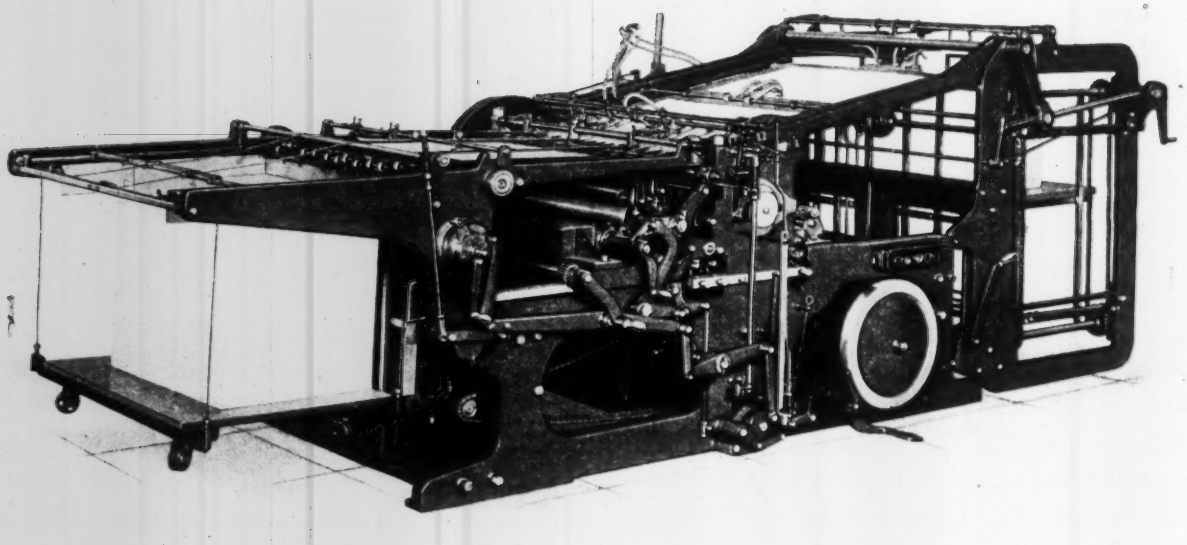


FIG. 2 AUTOMATIC TWO-REVOLUTION CYLINDER PRESS, MILLER PRINTING MACHINERY COMPANY, PITTSBURGH, PA.

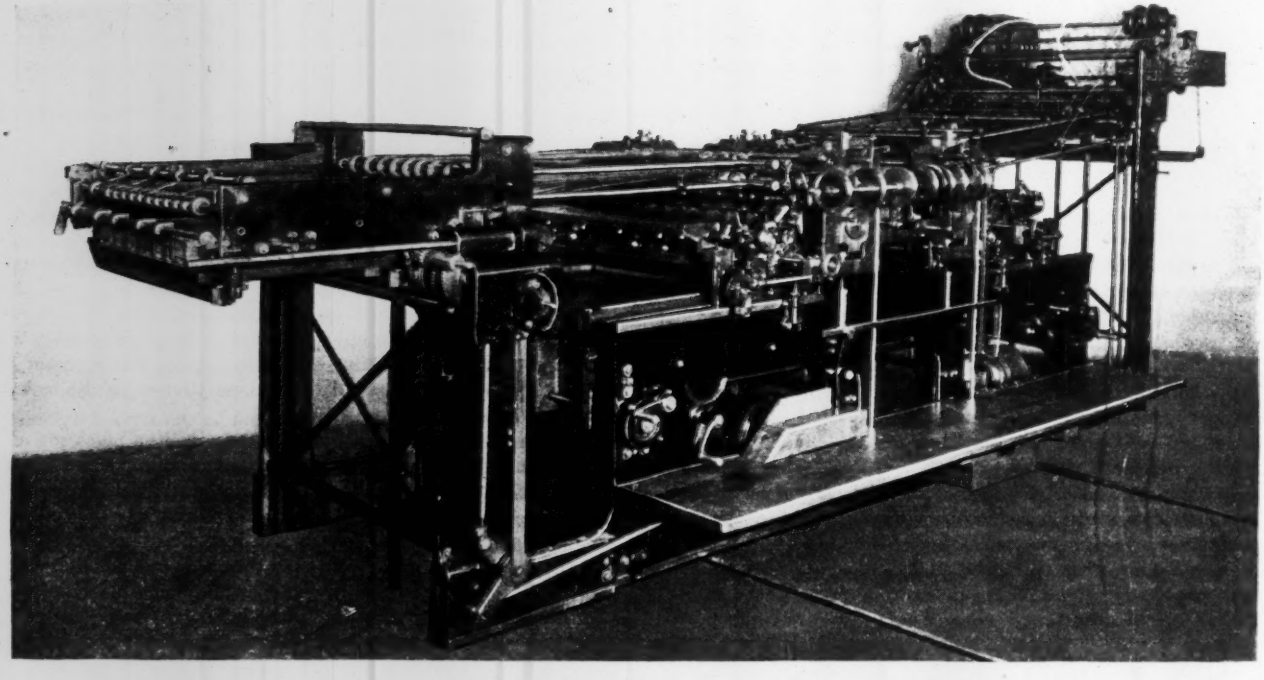


FIG. 3 TWO-COLOR FLAT-BED CYLINDER PRESS, HARRIS-SEYBOLD-POTTER COMPANY, CLEVELAND, OHIO

held the major field. In this machine, to which the vacuum system is readily attached, sheets are fed directly from the press without handling, are registered, seized by grippers, and carried under the bronzing pads. These are in a separate chamber which is not connected with the vacuum system, the powder being fed from a fountain adjustable in regard to quantity needed. The rollers for dusting are in separate chambers, a manifold connecting them with the vacuum system drawing off surplus powder and depositing it in a container for recovery. Sheets are dusted on both sides and the face burnished, adding luster to the work, which is finally delivered in a clean condition, sheet upon sheet, on to a descending delivery board. This machine would seem to have solved many of the problems of bronzing and made it more attractive for work of this character; its

speed is high, and the handling of sheets is reduced to a minimum.

In last year's report, attention was called to the trend toward smaller-size presses; history evidently is repeating itself, for this year a new two-revolution cylinder press has been brought out which is modeled after a smaller type taking a 20-in. × 26-in. sheet and enlarged to take a 27-in. × 40-in. sheet, thus illustrating a flow to and fro of press sizes which seems to apply to printing-press history. However, as changes are made, improvements develop either in the mechanisms or in means for operation with the least loss of time. In this new press, Fig. 2, there has been a studied endeavor to have a compact yet readily handled machine; the sheet feeder at the right is pivoted so that it can be swung away to give access to the type bed, while at the left the lowering delivery board is mounted on casters for easy removal. The press, as a whole, illustrates the trend toward compact structure and high-production features even when short runs are called for. The bed motion is ingenious and forms the subject of a paper contributed by the Printing Industries Division for presentation at the 1930 Annual Meeting of the Society.

Fig. 3 illustrates a small two-color flat-bed press recently brought out. Formerly two-color work was usually considered in terms of large sheets, but the spread of and demand for advertising display in colors and on comparatively small sheets, as well as the need for quick production, led to this machine on which a sheet 22 in. × 30 in. is the maximum size. These small machines are quickly made ready and run at high speeds, the design and arrangement of parts being such as to conserve floor space and also give ample working room. This press is also the subject of one of the papers at the Annual Meeting, in which the ingenuity of the application of many phases of the use of mechanical movements and precision work is presented. The illustration shows how much can be placed in a relatively small space, as well as the various mechanisms and their relations to each other, all of which must operate in exact synchronism. For instance, the inking mechanism can be run back from the impression cylinders to give access to them, and when returned find its exact position in correlation with the other parts to which it joins. The press is a good example of what can be done to combine automatic operation with accessibility and the production of fine work.

While on the subject of color work, mention may be made of an excellent article in the September issue of *The National Geographic Magazine*, "The Color Camera's First Aerial Success," which is of interest to the printing fraternity, for it not only describes how the colors are taken on one exposure, but also indicates the skill of the photoengraver and electrotyper in the production of printing plates in exact register; for the negatives were not taken in a camera having the firm and vibrationless stand considered necessary for color work, but from a dirigible with the unstable characteristics of a body floating in the air. The accomplishment is felt to be well worthy of recording in this report as an advance in the reproduction on the printing press of this achievement.

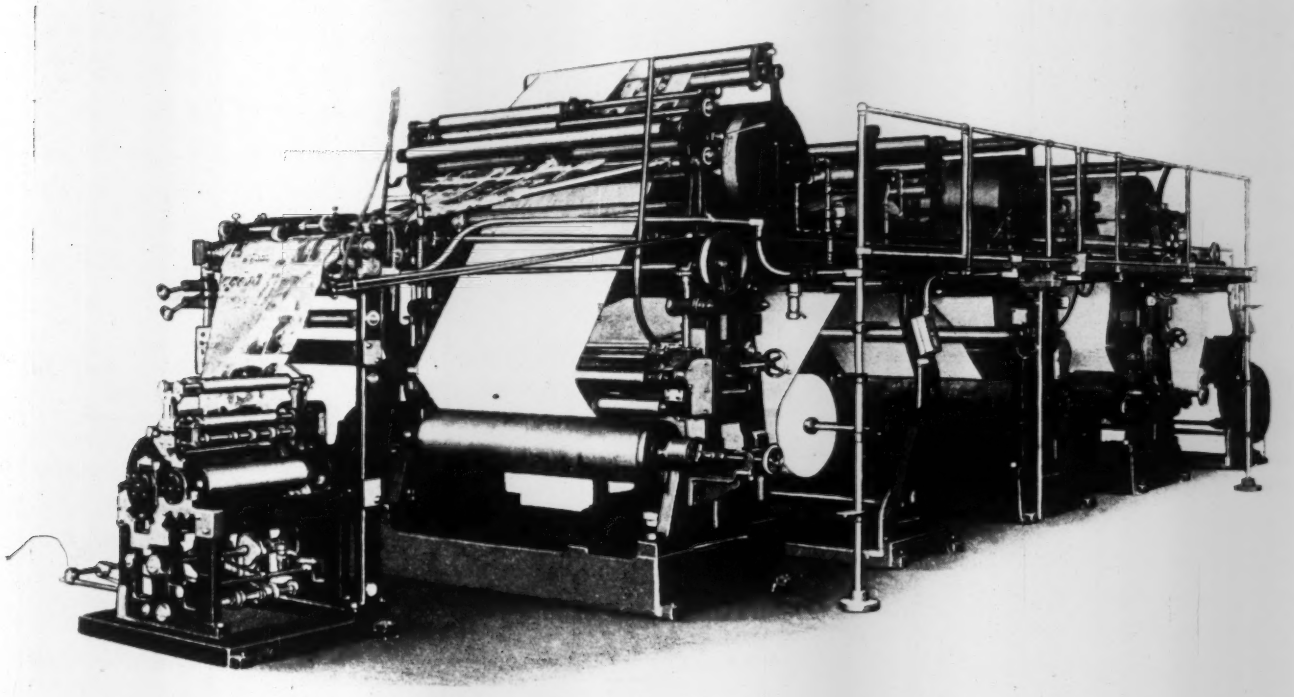


FIG. 4 HEAVY-DUTY WEB GRAVURE PRESS WITH ROTARY FOLDER, HARRIS-SEYBOLD-POTTER COMPANY, CLEVELAND, OHIO

There has been a feeling that stereotyping could not quite equal electrotyping in the production of the finer grades of plate work because of the difference between an electrodeposited face and one cast from hot metal. Research and laboratory work have recently developed a matrix having a very smooth face that will take the finest lines, the cast being of a definitely alloyed hard stereotype metal, giving, it is claimed, a plate equally clear in definition and capable of long wear comparable to that of an electrotype. Tests are now in progress to further develop the process to the point where, it is hoped, it will rival the electrotype as regards presswork.

Multi-color gravure work is growing more and more in demand, and while the single-color or familiar brown supplements of newspapers have reached a high stage of good work and production, color work, because of popular appeal, has compelled the development of the web multi-color gravure press. Fig. 4

illustrates a new machine taking a web of paper up to 72 in. in width. The press as shown has provision for two rolls of papers, and consists of three printing units. However, more units can be added to increase production or for additional colors, the arrangement in this respect being similar to the unit construction of a modern newspaper press.

In the picture, at the left, is shown a rotary folder which receives the printed web which has been slit, one half being carried over angle bars and imposed on the other half, both then going into the folder, where they are cut and folded to newspaper size. A description of one printing unit will answer for all, for except as to the colors used, they are essentially identical. The paper is led from the roll to between a plate cylinder and a rubber roller, the pressure of which causes the ink in the depressed or gravure copper surface of the plate cylinder to be transferred to the paper, which then runs over a large steam-heated drum of seamless steel tubing to dry the ink, which is very liquid and volatile. This ink is contained in a bowl or pan underneath the plate cylinder and is scraped from its surface by a long, thin blade which, however, leaves the ink in the etched design. At the lower portion of the left end of the press, one of the plate cylinders, which by the way is removable, is shown in printing position, the ink pan having been removed. The design on the cylinder is continuous, so that while the paper may be of different widths of web roll, the running length will be the circumference of the cylinder; and for color work where a plurality of colors is used, the diameters of the cylinders must be exactly alike to get proper register. Heat and stretch also affect register, and as the web of paper passes over the steam drum, it runs over water-cooled rollers to normalize it as far as possible, adjustable web-tension rollers between the printing units being also required to preserve register of the different colors.

The transfer of pictures on to the copper surfaces for color printing in particular is work of keen precision, and as these surfaces must be renewed for each run, their economical and speedy recoating involves a serious problem. A marked advance has been recently made in this direction, for while it formerly took considerable time to deposit a new face which had to be ground and polished, a novel method has been developed. This consists of first depositing a nickel shell and then on top of this a copper coating about 0.010 in. in thickness, it having been found that the copper film, while firmly held, could be stripped from the nickel base and a new surface quickly deposited, and this so smoothly done as to require only light polishing with the usual scotch stone. A very light coat of chromium can be deposited on the copper, thus adding to the life of the surfaces. There will undoubtedly be continued improvement and development in gravure work, particularly in colors, as this method has the feature of reproducing a subject or picture as the camera depicts it, and raises conjecture as to how far it can be carried to expedite production as compared with other present-day methods. Service stations are being established at convenient points where printing cylinders are prepared ready to be placed in the press; the entire process of plating the cylinder surface, transferring the pictures from carbon tissues thereto, etching, and final finish is quickly done, this service to the trade being somewhat akin to that of photoengravers and electrotypers, thus centralizing preliminary preparation and work, and reducing production time.

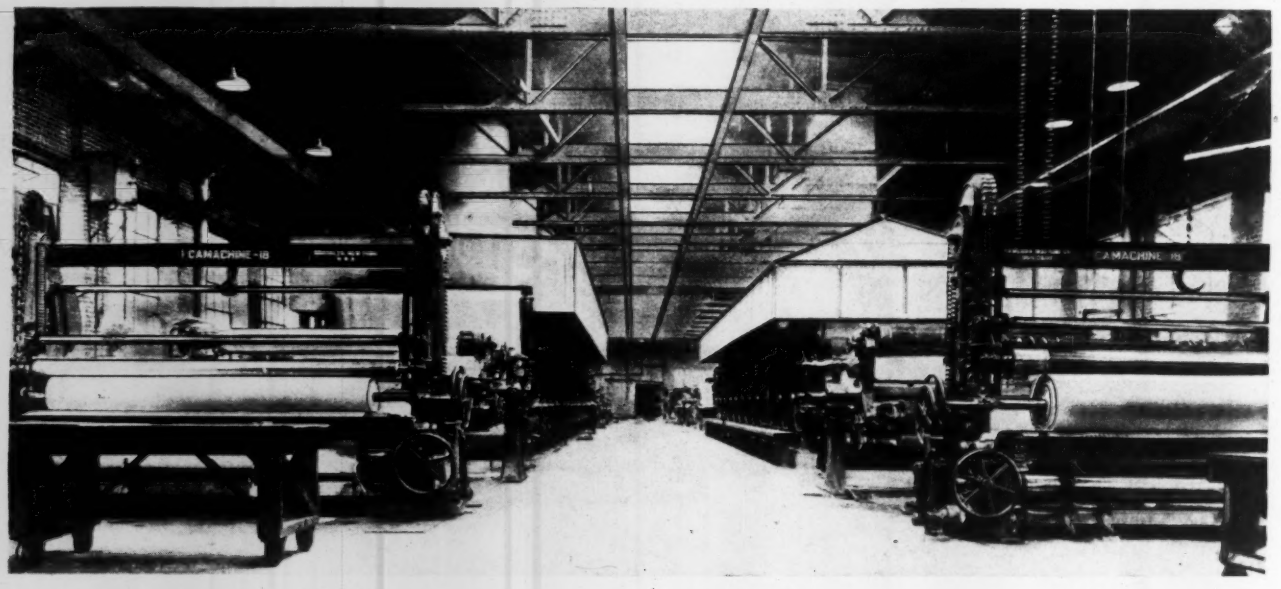


FIG. 5 GLASSINE-MILL MACHINE ROOM, CAMERON MACHINE COMPANY, BROOKLYN, N. Y.

The increasing use of cellulose material in the form of "glassine" and "cellophane" has brought with it problems in printing due to the structure of the stuff, and these are being successfully solved. Inks have been adapted to them and presswork modified to meet the peculiar face of the stock. There is a marked difference in the preparation of the materials mentioned, for while glassine is more of the nature of a web or paper processed and passed through a series of calendering machines, cellophane is allied to the chemical laboratory and produced as a film from wood or cotton pulps passing through various processes from steeping and acid treatments to glycerinating, drying, and finally emerging as finished film. Fig. 5 illustrates a glassine-mill machine room. At the far end the raw web is fed in and led through the converting and calendering process to the final roll winders, the processing machinery being covered by hoods for carrying off vapors. The winding of glassine into rolls presents problems differing from those of the usual run of papers. Being of a waxy nature, it requires a roll winder that will control the even winding of the web and produce a firm, compact roll of

uniform density, and that without too great vigilance or skill on the part of the operator of the machine.

Cellophane stock partakes more of the nature of a plastic mass of viscous quality, and in making it a film of the fluid stock is flowed from a hopper having an adjustable throat that regulates the thickness or from a hopper set to a fixed clearance over a rotating cylinder, whence it is coagulated into a continuous film, passing along through various processings until it issues from the drying rolls as a transparent, very thin web having considerable strength as compared with paper and quite elastic.

Glassine and cellophane being used for cigar wrappers, coverings for food containers, etc. have to be supplied in rolls of various widths, and these are cut or slit from the wide rolls in which it is made and then rewound in narrower units. While slitting is usually thought of as done by a scissors or shearing action, in this case, because of its peculiar nature, the material responds better and reels more uniformly to a scoring cut made by slitting wheels having semi-keen edges and pressing through the film upon a flint-hard and highly polished backing roller, as shown directly over the slitting wheels and upon which the film is rewound in the divided widths. The cuts are clean and overlapping of edges is avoided.

The purpose of referring to these two materials, which, incidentally, while now somewhat costly, have an increasing market, is to indicate the possibilities of such treatments of cellulose bases as leading to the more expeditious production of a web of paper suitable for rapid printing, say, for newspapers. Research and laboratory demonstrations have furnished practical results of economic value, and thought is now being given to how far they can be further developed for utilization in collateral branches.

In the October, 1930, issue of *World's Work* there is an article, "Pictures by Wire and Wireless," which presages much for the printing industry. As explained by its author, incoming wireless impulses actuate a tiny shield which alternately interrupts a fine jet of vaporized ink directed against a sheet of paper on a rotating drum, and the interruptions of the shield cause it to paint the picture directly on the paper much as an artist operates an air brush. The specimen of work shown is full of meaning. What with the progress in gravure and surface printing, the continuing developments in paper making, the vapor inking, possibly, too, reactions from the gases—what a combination it would be to have plates made instantly in multiple, placed on cylinders, inked by or from some modification of the vapor idea, paper run through at unheard-of speed, not from a roll but in plastic or fluid form fed from a container on to an apron or cylinder and instantly set as a film, no paper-roll replacements and many other advances—there is work ahead and aplenty.

The article in question concludes with this paragraph: "Is there anything ahead? Well, Owen D. Young says he isn't satisfied yet. His latest dream for the engineers is a contraption by which one can write a letter in his office and it will be instantly received in facsimile by the person to which it is addressed—wherever he may be. We shall see what the engineers are able to do with this large order." Well, there are other dreamers, too; we shall see what can be done, for the impelling urge is in the inspirational apothegm coined by Dr. George Pierce Baker for the Fiftieth Anniversary of the Society: "What is not yet, may be!"

WINFIELD S. HUSON, *Chairman.*

Progress Report Committee of the Printing Industries Division.

Progress in Oil- and Gas-Power Engineering

Contributed by the Oil and Gas Power Division

Executive Committee: L. H. Morrison, *Chairman,* E. J. Kates, *Secretary,* H. A. Pratt, Harte Cooke, L. M. Goldsmith, and L. R. Ford

DURING the past year there were no announcements of revolutionary or radical developments in the oil- and gas-power field. This is not to say that no progress has been made, for the contrary is true. Considerable progress has been effected by the working out and the refinement of developments inherited from past years.

The oil-engine industry has suffered along with other industries in the present world-wide depression. Exact data on the volume of business are not at all complete, but based upon reports from five of the leading domestic companies in the field, the bookings in horsepower for the first six months of 1930 were approximately 90 per cent of the corresponding 1929 figures. Although three large pipe-line Diesel orders have been placed since the half-year point and the positions of several companies have thereby been improved, it is doubtful if the general situation is improved at this writing.

Two large capital groups—the American Locomotive Company and the General Motors—entered the Diesel industry during the year, the first by the acquisition of the McIntosh & Seymour Corporation, the second by the purchase of the Winton Engine Company.

The gas-engine business, due to the great extensions to natural gas-pipe-line systems, has been very good. Specific figures are lacking, but it is generally known that the leading manufacturers of engines have large backlogs of orders that they are working overtime to execute.

STATIONARY INSTALLATIONS

Undoubtedly the most spectacular stationary installation of the year was that of the Pedro de Valdivia station of the Anglo-Chilean Consolidated Nitrate Corporation.[1] Here five M.A.N. double-acting, two-stroke, air-injection engines, each seven-cylinder, will make a total of 23,500 hp. in one station. Added to seven 1500-hp. engines and two 5600-hp. units in nearby stations, this plant will make a total of 45,200 hp. in one interconnected system.

The M.A.N. Company is also reported to be furnishing two 12,000-hp. double-acting engines for the Hamburg Electric Light Works, these to supplement the 15,000-hp. unit which has been operated there for some time.

[1] Numbered references in the text relate to the bibliography at the end of the report.

Sulzer Brothers are supplying a 6300-hp. engine for the Shanghai, China, electric-light plant. This is the seventh Sulzer engine for this plant, and will make a total of 31,000 Diesel hp. under one roof. They are also furnishing six 2900-hp. engines for a new power station at Broken Hill, Australia, which will replace several small steam plants belonging to a mining company. The first engine will be in service early in 1931. They report a growing interest in Diesel engines for hydroelectric station stand-by power, and also find that larger engines are being considered—several as large as 20,000 hp. being now contemplated.

In the United States, one of the most-talked-of installations of the year was that of two 1000-hp. Fulton, four-stroke, air-injection engines in the department store power plant of R. H. Macy & Company, New York City.[2] These are eight-cylinder units, and the plan is to supercharge them at some future date when power requirements increase. Another installation of a similar character was that of a 535-hp. De La Vergne engine in the power plant of the Hotel New Yorker.[3] Both this plant and the Macy installation offer exceptional opportunities for the balancing of heat and power, for each is operated in connection with a steam plant.

One of the largest users of Diesel power in this country—the Phelps Dodge Corporation—increased the number of Diesels operated by it by installing one 2250-hp. unit at Globe, Arizona, where two 1250-hp. engines were already in service; another 2250-hp. unit at Warren, Arizona, where there were already two of that size; and a third 2250-hp. engine at Morenci, Arizona, alongside six 1250-hp. units. These engines were supplied by the Nordberg Manufacturing Company, of Milwaukee.

In addition to these three engines for Phelps Dodge, the Nordberg Company also furnished a 4000-hp. unit for the Commerce Mining and Royalty Company, Cardin, Oklahoma, making a total of 10,750 hp. of Diesel engines in this plant; a 2400-hp. engine for the Texas-Louisiana Power Company, Pecos, Texas; and two 1760-hp. engines for the Ottertail Power Company, one for Langdon, North Dakota, and the other for Appleton, Minnesota.

Busch-Sulzer Brothers have recently sold a 4000-hp. Hesselman-type mechanical-injection engine to the Tucson Gas and Electric Company, which now operates two 3750-hp. Busch-Sulzer units. This new addition will make a total of 15,540 hp. of Diesel engines in this plant. The Busch Company has also closed an order for a 3000-hp. engine of this type with the town of Freeport, Long Island, New York.

One curious illustration of Diesel economy was an installation during the year of 1440 hp. of Fairbanks-Morse engines in the plant of a West Virginia coal mine, where steam power might be expected to show to best advantage.

Many correspondents testify to an increasing interest in Diesel power on the part of municipalities, industrial-plant executives, and the general public. The spectacular achievements of the Diesel in the locomotive and airplane fields are no doubt responsible for the general public interest, although successful performances of existing stationary installations probably account for the municipal and industrial interest.

Nothing radical has transpired in the portable and semi-portable field, although developments have been steady, with P. & H., Bucyrus, and Marion selling Diesel-powered shovels and drag lines as a matter of every-day business and in ever-increasing quantities. It has been stated that approximately 500 Diesel engines are absorbed every year by drag-line and excavator requirements.[4]

The Marine Diesel Situation

From a world standpoint, the marine Diesel situation has never been better. World tonnage under construction at the end of June, 1930, was 1,117,624 steam and 1,920,505 Diesel[5]—a decrease in steam tonnage from last year and an increase in Diesel tonnage. The figures are more striking if taken for one size range, that from 6000 to 15,000 tons. Here we find 160 motorships under construction as opposed to only 39 steamships.

The *Britannic*, the world's second largest motorship, announced in last year's report, went into service in May, 1930, and has since shown a highly satisfactory performance. It is worth while repeating that this ship is propelled by two Harland-B. & W. four-stroke, double-acting, air-injection engines of 10,000 s.hp. each.[6]

The largest French motorship, next to the *Britannic* in the world line-up, the *Lafayette*, with 18,000 s.hp. on four shafts, made her maiden voyage from Le Havre to New York in May, 1930. The main propulsion units in this ship are M.A.N. engines of the double-acting, two-stroke, air injection type.[7] These two large Diesel ships bring the total of passenger motor vessels of 20,000 tons (gross) and over to nine.

The M.S. *Amerika*, the first vessel to have Burmeister & Wain double-acting, two-stroke, mechanical-injection engines, has completed two long voyages, one to the Far East and one to the west coast of the United States. These engines are reported to have shown an overall fuel consumption of 0.365 lb. per b.hp-hr.,[8] thus setting a new mark for motorships to shoot at.

The gear-drive motorships *St. Louis* and *Milwaukee*, also referred to in last year's report, have so operated as to call attention to the merits of this method of connecting Diesel engines to propellers. The combined weight of engines and gearing is said to be but 125 lb. per s.hp.[9]

Another famous gear-drive installation—that on the German cruiser *Ersatz Preussen*—once reported to total only 17 lb. per s.hp., has since been more reliably announced to weigh 50 lb. per s.hp.—still a very remarkable figure.[10]

The Sulzer-engined *Asama Maru*, in service since the beginning of the year, established a new record on her fourth run between Yokohama and San Francisco, and is now the fastest motorship on the Pacific. The *Tatsata Maru*, built several months later, has exactly similar Sulzer-design machinery constructed at the Mitsubishi shipyard. Sulzer Brothers report that there are now over 3,500,000 hp. of Sulzer-system engines in service and under construction.

The motor-passenger-ship status can be illustrated by citing the figure of 58 motor passenger liners of 9000 tons (gross) and over—or a total of 855,000 tons (gross)—in service at the end of June, 1930, with 24 passenger ships of this size range on order, aggregating 335,000 tons (gross).[11]

The marine situation in the United States does not show anything like the variety and progress of that of Europe. In the list of motorships of all classes between 6000 and 15,000 tons under construction on June 30, the United States has only three as against 160 for the world. The immediate reason for this situation is partly to be found in the present unfavorable price differential between boiler oil and Diesel oil in the eastern seaboard ports. Another factor in the situation is the unwillingness of ship owners on the one hand to order engines of sizes hitherto undeveloped, and the natural reluctance of Diesel builders on the other to bring out new and larger sizes without some assurances of a continuing market. In Europe what almost amounts to a quantity-production system is made possible by the numerous building programs of standard ships. During the year a move toward ship standardization has been made by the National Council of American Shipbuilders. It is too early to say what the result of this will be. Should it be successful, however, the Diesel program would benefit greatly.

The Jones-White shipping subsidy has been disappointing from a Diesel standpoint. Only one motorship—the *City of New York*—has been built under its provisions. The assumption is not made here that all ships should be motorships. Experience has shown that a careful study of individual trade routes should be made before determining what type of power should be used. However, in the opinion of eminent American ship operators, Jones-White grants have been made for steamships to operate on long trade routes where motorships would be far more economical and successful in competition with foreign-flag motorships. The responsibility lies with the operators, as the Shipping Board has no authority to do more than assure itself that a "modern" power plant is used.

It has been reported that the next naval appropriation bill will request $3,000,000 for the development of Diesels for scout cruisers.[11] This is no doubt an outgrowth of the world-wide interest in the *Ersatz Preussen* and the three German cruisers with cruising Diesels.

It is not generally known that one domestic shipyard—the Sun Shipbuilding & Dry Dock Company of Chester, Pa.—has launched during the past year seven motor tankers of 13,500 tons deadweight each, and one combination freight and passenger liner (the *City of New York*) of 10,000 tons deadweight. Each of these tankers has one engine of 2800 s.hp. The freighter-passenger ship has two engines of 2700 s.hp. each. The aggregate horsepower of the eight ships was 26,000 and the tonnage 104,500 dw.c. This plant has now on order nine more motor tankers aggregating 25,200 s.hp. and 121,500 tons dw.c. All ships have been and will be powered with Sun-Doxford, opposed-piston, two-stroke, mechanical-injection engines.

It is significant that the Sun Company is the only American shipbuilder operating an engine plant, or—if preferred—the only American Diesel-engine manufacturer also operating a shipyard. The motor-shipping outlook at this plant is quite optimistic, and the indications are that the hull-building capacity will shortly be so extended that business will have to be turned away. In view of the fact that much of the existing tanker tonnage is due to be scrapped soon, this date may not be far off.

The Pusey & Jones shipyard at Wilmington completed four large yachts last fall with main power plants aggregating 7600 s.hp., and later secured the contract for four large Diesel-electric tugs aggregating 4000 s.hp.

The world's largest tow boat is being built at Dubuque, Iowa, for the use of the Inland Waterways Corporation. It will have two 1100-hp. McIntosh & Seymour engines on twin screws.

There has been a pronounced upward trend in the construction of Diesel-powered river tow boats, due largely to the completion of the improvements to the Ohio River below Pittsburgh.

Completion of six Diesel-electric lightships, each of 350 s.hp., marked the entry of the Bureau of Lighthouses into the Diesel market.

The construction of steel trawlers for the Atlantic coast—a good business a year ago—has suffered a falling off. However, the Pacific Coast fishing program is calling for bigger and faster boats because of the fact that fishermen must go farther out than formerly to secure a good catch. A few years ago a 70-ft. boat holding 40 tons of fish and with a 100-hp. engine was considered a good-sized boat. This year quite a number of boats have been built from 100 to 125 ft. in length, with 150 tons fish capacity and with 500-hp. engines. One correspondent states that next year he expects to see 200-ton boats with 1000-hp. engines.

Diesel Aviation Developments

Progress in aircraft-Diesel-engine development in 1930 has—especially in connection with Diesel engines which had their first flights in 1929—been strikingly parallel to the normal cycle of service tests and detail refinements which has always been found necessary in the evolution of improved types of airplane gasoline engines.

In numerous cases the initial stages of experimental design have been passed and a period of adaptation and acquisition of experience in aviation-Diesel operation in regular commercial service has begun.

The Packard aviation Diesel engine was approved for air service by the Aviation Branch of the Department of Commerce in March, 1929, and since that date installations have been completed in numerous types of airplanes and flying boats. Particular attention is being paid at the present time to further refinements of design and to the elimination of exhaust smoke. The initial engine has been developed to give a 225-hp. rating. The development of additional sizes and types by the Packard Company may be expected.

In this connection tribute must be paid to Capt. Lionel M. Woolson, formerly director of the Packard Diesel-engine developments, whose untimely death in an airplane crash early this year cut off a career which had already achieved a remarkable pioneer influence in Diesel-engine activities.

Service tests and design refinements are understood to be under way in Germany in the adaptation of the Junkers aviation Diesel to commercial service. It is reported that flights have been made by the Luft Hansa Air Service with Junkers Diesel engines, and unsubstantiated rumors of radical design changes have been current for some months.

The British experiment with Diesel airship motors was tragically interrupted by the *R-101* disaster on October 4, 1930. Shortly before this, the Diesel propulsion units in this pioneer installation had been improved considerably. The five Beardmore 650-hp. engines were operating at a speed slightly below the original rating; at least one of the engines had been successfully equipped with reversing gear for maneuvering; and the gasoline-operated auxiliary starting mechanism had been improved. Although the Diesel motors weighed more than the gasoline-motor plant of the *R-100*, the preliminary reports of the disaster favor the theory that the Diesel plant was in no way responsible.

European Diesel-engine developments for aviation which are still in the experimental stage, or on which details have not as yet been released, include a nine-cylinder, radial, air-cooled Diesel by Clerget; a development reported to be sponsored by the English Sunbeam Company; and numerous theoretical researches and studies under way by many other recognized builders of high-speed, light-weight Diesel engines.

In the United States a program of Diesel research, aimed especially at aviation problems, is being conducted by the National Advisory Committee for Aeronautics; by the Emsco Company; by Osbourn & Company, and by various other private organizations. The publication of articles and technical studies of possible aviation-Diesel performance has continued on an unusually prolific basis, which doubtless indicates a very healthy degree of interest in aviation-Diesel work, but which has had the disadvantage of arousing popular expectation of a complete Diesel aviation power plant in a somewhat shorter time than such developments must, of necessity, require.

Automotive Diesel Progress

A steady and consistent refinement and evolution of new types of automotive Diesel engines has been noted in the past few months. This progress has been sponsored by two outstanding conditions: (1) the constant European demand for cheaper truck and bus operation—which is beginning to be reflected to a

limited degree in the United States as well—and (2) the fact that the conditions of automotive service are easier for Diesel-engine builders to meet than the much more rigorous conditions of aviation service.

In America the first "official" recognition of an automotive-Diesel record was obtained when C. L. Cummins received sanction from the American Automobile Association for a record of 80.398 miles per hour accomplished in a Cummins-powered Diesel "racing car" at Daytona Beach, Florida. It is interesting to note that this car was driven from Indiana to Florida, a distance of 1060 miles, with a fuel cost of $1.95.[4] This car was powered with a four-cylinder, four-stroke, 50-hp. Diesel engine of orthodox design, developing a maximum speed of 1500 r.p.m.

The first endurance run with an American-built Diesel truck was accomplished in a Reo speed wagon, powered with a standard Hill Diesel engine, fitted with a Bosch fuel pump. The total mileage for the run was 1478, during which 74 gal. of fuel were consumed at a total cost of $5.02, the pay cargo totaling 2300 lb.[12]

A survey made abroad in October, 1929, showed that at that time there were 245 Diesel trucks in Germany and 65 Diesel trucks of German manufacture in other countries. In addition, there were 230 Diesel trucks in other countries built under German licenses. Most of these trucks were made by the M.A.N., Daimler-Benz, Deutz, and Junkers companies, and most of them utilized the Acro-Bosch fuel system.[13]

The first American company to experiment with Diesel buses has submitted a statement which may be profitably quoted more or less in full. This is the Public Service Coordinated Transport, a subsidiary of the Public Service Corporation of New Jersey. The statement follows:

> Public Service Coordinated Transport of New Jersey has continued this year the Diesel bus experiment which was started in 1929. It may be of interest to note that as far as is known this is the first Diesel bus in the United States and the first Diesel-electric bus in the world. A standard Diesel truck engine was first used. This was 105 mm. bore, 165 mm. stroke, 6 cylinders, weighing 1600 lb., and developing 70 hp. at 1300 r.p.m. The bus was placed in regular city operation last fall, and the results throughout the winter were very encouraging.
>
> The Mercedes-Benz Company then built several experimental Diesel engines designed especially for bus service. One of these was imported and installed in a bus last March. The dynamometer and road tests were very satisfactory and the bus was placed in regular service in Newark, N. J. . . . This bus has since been running in regular operation on a route with conventional gasoline buses, and so well does its performance compare with the conventional type that passengers have never been aware that a Diesel engine is being used.
>
> This is a six-cylinder Mercedes-Benz engine, having a bore of 100 mm. ($3^{15}/_{16}$ in.), a stroke of 150 mm. ($5^{29}/_{32}$ in.) and a rating of 75 hp. at 1600 r.p.m. It is fitted with a Robert Bosch fuel pump and injection nozzles. The engine is started from cold with an electric starting motor after heating "glow plugs" in the combustion chamber for about 30 sec. The engine is controlled by a conventional foot accelerator pedal which regulates the amount of fuel injected into the cylinders. Public Service has operated this bus on fuel oils ranging in gravity from 26 to 42 deg. Baumé. The oil generally used in operation has been a Diesel fuel oil of 30–36 deg. Baumé. This fuel costs approximately half as much as gasoline and gives better mileage per gallon. The low fuel cost of the Diesel engine is the most attractive feature to bus operators, but the fact that the entire ignition system and carburetor are eliminated is of great importance; the ignition system being usually responsible for a considerable proportion of road failures. The fire hazard is, of course, practically eliminated, which is quite important in connection with public vehicles.
>
> The bus is a Yellow Coach Model Z-240, fitted with General Electric Company's electric-propulsion units, and body by the Public Service. In fact, the entire bus, with the exception of the Diesel engine, is one of the Public Service standard models. It has a 240-in. wheelbase, is fitted with 9.75–32-in. balloon tires, and has a 31-passenger body with space for standees. The total weight of the bus without passengers is 18,500 lb.
>
> The results of both tests and actual operation have been so satisfactory to the company that its engineers are quite optimistic regarding Diesel bus engines.

Railroad Diesel Progress

Although there were 1134 rail motor cars in service on September 1, 1930, only a few of them were powered with Diesel engines, and these are regarded as more or less experimental. Diesel developments in the railroad field are still predominantly locomotive developments.

The progress reports presented in 1929 by the Oil and Gas Power Division and by the Railroad Division mentioned the Canadian National oil-electric locomotive No. 9000 as the most powerful unit of its kind ever built. This locomotive is still considered by railroad men to be the outstanding Diesel-electric power unit in service in America. Of interest at this time is the fact that the two engines of this locomotive have demonstrated their ability to develop in service their full rated capacity of 2660 hp. A notable feature of this locomotive is the high speed at which the oil engines operate—800 r.p.m.—and the correspondingly low weight. A comparative test of this locomotive and a 4-8-2 type steam locomotive, No. 6000, was made by the Canadian National.[14] A comparison of selected dimensions and data pertaining to these two locomotives is shown in Table 1. At a speed of 20 miles per hour the tractive force of the oil-electric locomotive is the same as that of the steam locomotive (40,000 lb.); at lower speeds it is materially in excess of that of the steam locomotive (100,000 lb. as compared to 51,000 lb. at around 6 m.p.h.), while at higher speeds the tractive force of the steam locomotive is the greater (roughly 4000 lb. greater up to 60 m.p.h. after a speed of 30 m.p.h. has been attained).

The advantage of the high tractive force at starting and at slow speeds was evident in the rapidity with which the Diesel-electric locomotive was able to accelerate a train of $663^1/_4$ tons during the demonstration trip. General observations indicate that locomotive No. 9000 will bring a train of this weight up to a speed of 60 miles an hour in about one-half the time required by steam locomotives similar to No. 6000. Based on voltmeter and ammeter readings, the maximum combined horsepower output of the two Diesel engines did not exceed 2100 hp. at speeds of 60 m.p.h. or higher. At speeds up to 45 m.p.h., however, when handling the train up ascending grades, the engines developed between 2500 and 2600 hp. for several minutes at a time. In starting and accelerating the train the full horsepower rating of the engines was developed for short periods. On one occasion the train attained a maximum speed of 73 m.p.h., which was sustained for a short time, with a power output of approximately 1800 hp. Speeds of 60 to 65 m.p.h. were frequently reached and maintained for considerable periods.

During the demonstration trip the exhaust from the engine of the rear unit showed a brown haze both while idling and while

TABLE 1 SELECTED DATA AND DIMENSIONS OF CANADIAN NATIONAL OIL-ELECTRIC AND 4-8-2 TYPE STEAM LOCOMOTIVES

	Oil-electric locomotive No. 9000	Steam locomotive No. 6000
Total weight	668,000 lb.	594,860 lb.[a]
Weight on drivers	461,904 lb.	231,370 lb.
Number of driving wheels	16	8
Diameter of drivers	51 in.	73 in.
Engines	2 1330-hp. Beardmore: oil engines	.....
Generators	2 Westinghouse No. 478	.....
Auxiliary generators	2 Westinghouse YG-8	.....
Motors	8 Westinghouse No. 359 Railway	.....
Gear ratio	22:69	.....
Evaporative heating surface	.....	4049 sq. ft.
Superheating surface	.....	810 sq. ft.
Grate area	.....	66.7 sq. ft.
Cylinders	.....	26 in. by 30 in.
Steam pressure	.....	210 lb.
Maximum tractive force	100,000 lb.	49,600 lb.
Sustained tractive force	42,000 lb.	.....

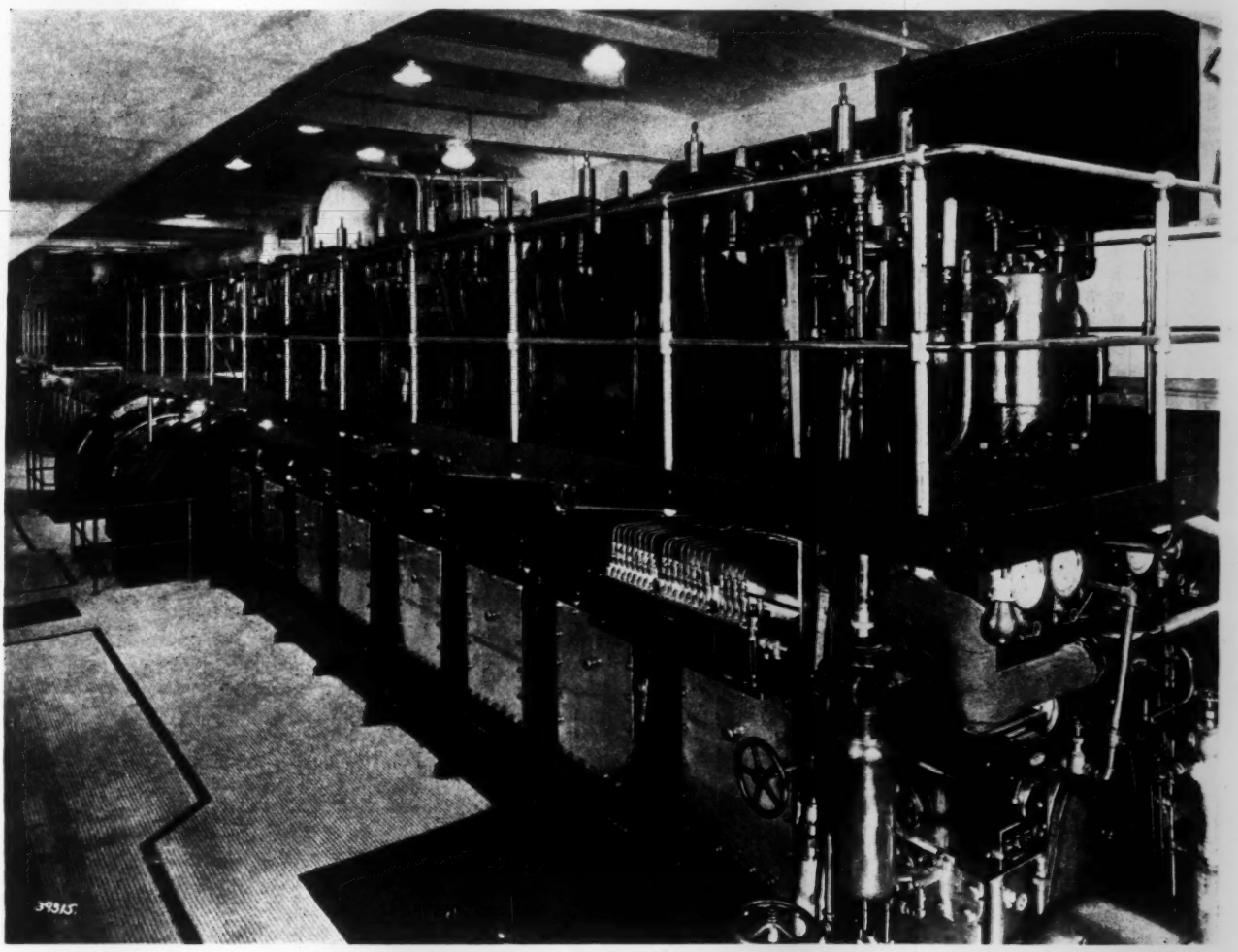
[a] Including tender.

developing full engine speed. The exhaust from the engine of the front unit, while visible, was considerably less noticeable.

No reports relative to the operation of the Baldwin 1000-hp. Diesel-electric locomotive equipped with the Krupp Diesel engine or the 900-hp. Diesel-electric passenger locomotive built by the American Locomotive Company for the New York Central have been made public. Both of these locomotives were referred to in the progress reports of the Oil and Gas Power Division and the Railroad Division last year.

exhibited marine Diesel engines. All were mechanical-injection, many were rated between 600 and 1000 r.p.m., and weights ran as low as 13 lb. per b.hp. in one instance, with several in the 30-lb. class. Two of the exhibited models were of V-construction—the Treiber and Winton. The former is a 12-cylinder engine rating 300 hp. at 1000 r.p.m. and weighing but 3800 lb.; the latter is a 16-cylinder unit rating 650 hp. at 750 r.p.m. and weighing 18,500 lb.

In this country the trend toward lighter weight is progressing chiefly in the small- and medium-size engine field. Mechanical



TWO 1000-HP. FULTON DIESEL ENGINES INSTALLED IN POWER PLANT OF R. H. MACY & CO.'S DEPARTMENT STORE, NEW YORK CITY

A total of 113 oil-electric locomotives were in service or on order in the United States and Canada on September 1, 1930.

ENGINES AND ENGINE DESIGN

Weight reduction is the present-day aim of engine designers. To this end speeds are being increased. Whereas piston speeds of around 900 ft. per min. were once the rule for heavy-duty units, now standard practice is approaching 1200 ft. per min. Increased knowledge in the construction and operation of engines, improvements in combustion arrangements, and new alloys and steels are making this development possible. Deutz, for instance, call our attention to the fact that it manufactures 1000-hp. engines to turn at 375 r.p.m.

At the Marine show[15] in New York last winter, twelve firms

injection is playing a part here, and there is a tendency here as in Europe to pass more and more to this type of injection as opposed to air injection.

There has been a tendency to turn the design and construction of the mechanical-injection fuel pump over to specialists in that field—such as Bosch, Deckel, and R.E.F. One of these announces that he is prepared to take care of the fuel-injection requirements of the largest Diesel built at the present time.

The use of aluminum and aluminum alloys has become so commonplace that most correspondents neglect to mention it. However, the nitriding of steel is to the forefront, and many consider it the most important metallurgical development of the past several years from the Diesel standpoint. It seems to quite overshadow chromium plating—once regarded as highly

significant. The nitriding process is considered chiefly for pistons, rings, liners, crankshafts, and injection-pump parts.[16]

The U. S. Navy Yard, New York, can now cast cylinder liners up to 24 in. by a centrifugal process, and finds that it is possible to increase tensile strength and hardness without increasing machining difficulties. This yard also reports that corrosion- and heat-resisting steels for valves result in many more hours between grindings.

Burmeister & Wain favor "Perlit" for the castings exposed to heat. Great experience is necessary, they say, to make big castings of this material, but when successful, "Perlit" castings are more resistant against heat stresses and wear.

Dr. Sass reports that he has adapted a process for making engine parts subjected to heat and pressure stresses partly of cast steel and partly of wrought iron, these two materials being copper-soldered in an atmosphere of hydrogen.

The largest domestic builder of Diesels, Fairbanks, Morse & Co., brought out a new line of direct-mechanical-injection engines during the year. These engines have separate scavenging pumps instead of the familiar crankcase compression of previous models.[17] The result of the improved combustion system has been an appreciable reduction in fuel consumption.

The oldest domestic Diesel manufacturer, Busch-Sulzer Bros., have announced the acquisition of a license under the patents of the A.E.G., of Germany, and K. J. E. Hesselman, of Sweden, and also arrangements for technical cooperation with these firms —including the well-known Dr. Sass—that will enable them to build large and small mechanical-injection engines, as well as double acting engines. The company plans to combine the best that these arrangements can afford with the best Busch-Sulzer constructions.

Abroad we find the same tendency toward higher speeds and similar metallurgical refinements. Mechanical injection is gaining ground not only for small- and medium-sized engines but for large engines as well. The goal of less weight and space for more power is being sought by two roads—one is the use of pressure charging for four-stroke machinery; the other is the employment of two-stroke machinery. Both schools are resorting to double-acting engines more and more.

Pressure charging of European marine engines is no longer a theory but an every-day occurrence. There are several well-defined methods—the Büchi, the Werkspoor, the Lorenzen, and the Rateau; these employ exhaust-gas turbo-blowers except the Werkspoor, which uses the under sides of the pistons as compressors. Practically all are agreed that engines can be designed for pressure charging with a 40 per cent increase in horsepower per given unit of cylinder volume—some claim 50 per cent increase. Among the numerous instances of pressure-charged engines the order of the Anglo-Saxon Petroleum Corporation for 18 tankers, each to have Werkspoor-system supercharged engines, is noteworthy.[18] The Werkspoor Company has 80,000 hp. under construction with the Werkspoor pressure-charging system.

Along with pressure charging, exhaust-heat recovery is becoming characteristic of European marine practice. The *Britannic*, for instance, has four exhaust-gas boilers for 100 lb. steam pressure, with an approximate generating capacity of 10,000 lb. of steam per hour.

The healthy European marine situation is the motivation behind the pressure-charging progress and the two-cycle, double-acting program. The logical outgrowth is the tendency of European builders to develop larger and larger sizes. The Hamburg 15,000-hp. M.A.N. engine has long stood out as the largest Diesel in the world. However, at least two builders announce that they are ready to construct larger engines. Burmeister & Wain are prepared to undertake the construction of two-stroke double-acting engines, similar to the design of the *Amerika* engines, as large as 12,500 kw. for stationary plants. Sulzer Brothers are also branching out into larger sizes and state that they are prepared to offer two-stroke double-acting engines for land or marine use up to about 20,000 to 25,000 hp. per unit. They are now building a double-acting engine of 7000 hp. for a Dutch motorship, and an 11,000-hp. engine for an electric power plant. What the weights of these units will be is not stated. However, Sulzers' single-acting crosshead design, made up to about 3000 hp., weighs less than 60 kg. (130 lb.) per b.hp. Sulzers are also manufacturing mechanical-injection engines of four-stroke design.

RESEARCH

Research by the National Advisory Committee for Aeronautics has included the investigation of the operating characteristics of high-speed fuel-injection systems suitable for aircraft engines. A method has been developed for determining the instantaneous injection pressures at the discharge orifice of an automatic injection valve by recording the movement of the fuel-injection valve stem.[19] By analyzing these records, it has been possible to determine the injection characteristics of a common-rail fuel-injection system. The same apparatus is being used to check experimentally Sass's adaptation to fuel pumps[20] of the Allievi theory of variable liquid flow through conduits. The results obtained so far indicate that, with a few modifying assumptions, the theory checks the experimental data reasonably well.

The work of the coefficient-of-discharge investigation has shown that for the small sizes of nozzles employed for high-speed oil engines, a smooth passage between the upstream and throat of the orifice is necessary for a high efficiency of flow. A beveled leading edge to the orifice gives higher efficiencies than a rounded leading edge. The coefficient of discharge was found to depend on the geometrical shape of the nozzle, and not on the diameter of the orifice.[21,22]

The effect of injection pressure and chamber pressure on spray penetration and spray shape is being determined with the N.A.C.A. spray-photography equipment. The range of orifice sizes investigated varied from 0.014 to 0.040 in. in diameter with orifice length-diameter ratios of 1, 2, 3, and 4. Spray-penetration data have been determined for injection pressures from 2000 lb. to 8000 lb. per sq. in., and chamber pressures from 65 lb. to 250 lb. per sq. in. The results indicate that the orifice length-diameter ratio giving maximum spray penetration is approximately 4. For the range of orifice sizes tested, the effect of orifice length-diameter ratio on the angle of the fuel spray is negligible.[23]

The effect on engine performance of fuel-spray distribution obtained by varying the size, number, and direction of the orifices in an automatic fuel-injection valve has been determined for a single-cylinder engine having a vertical disk-type combustion chamber.[24] The engine-test results indicate that impingement of the fuel spray on the piston and chamber walls is not necessarily detrimental to combustion, but may be an aid to distribution. Small filler jets placed between large jets were found to aid distribution.

An important contribution to the information on the dispersion of fuel-oil sprays has been made by the oil-spray investigation of the Pennsylvania State College.[25] By weighing segments of blotting paper arranged around the fuel spray in the form of a "spiral stairway," it has been possible to determine the weight of fuel in the spray passing the area represented by the blotting paper. By placing the "spiral stairway" under pressure in the spray chamber, the effect of air density on fuel-spray dispersion can be investigated.

There is no doubt that considerable research work is being

done by several oil-engine manufacturers with the object of developing high-speed oil engines. However, very few of the results of this development work are available at the present time.[26,27]

The outstanding performance for a high-speed oil engine is that given by Ricardo.[28] Using a single-cylinder sleeve-valve engine having $5^1/_2$ in. bore, and a 7-in. stroke, an indicated mean effective pressure of 112 lb. per sq. in. and a fuel consumption of 0.29 lb. per i.hp. per hour have been obtained at an engine speed of 1300 r.p.m. The excess-air coefficient was 1.20. The maximum cylinder pressure was 800 lb. per sq. in., as determined with a Farnsboro indicator. The mechanical efficiency of the test unit was 80 per cent. This test engine has also been operated at speeds of 2200 r.p.m.

Fairbanks, Morse & Company reports that by research on fuel-injection systems and combustion, the fuel consumption of its two-stroke engine has been reduced by approximately 10 per cent. The Westinghouse Company reports research activities along the lines of fuel injection and combustion, and also on methods for reducing liner wear. Sulzers, in Europe, report research on fuels and also on torsional vibration. Dr. Sass reports that he is investigating the size of oil drops in fuel sprays into compressed air.

Alan E. L. Chorlton[29] reports the following British activities in research:

Imperial College of Science: Combustion
National Physical Laboratory: Combustion; piston-ring and liner interaction; use of alloy steels and special metals
Cambridge Laboratory: Fuel jets and ignition
Admiralty Laboratory: Pressure charging; piston-ring and liner interaction.

NATURAL-GAS POWER PROGRESS

The development of the year in the natural-gas power field is the continued large-scale expansion of the natural-gas pipe-line network in this country. Early in the year the *Oil and Gas Journal*[30] published a map of natural-gas lines in existence and building which showed lines in 27 states. Since then several more states have been added to the list of those served by natural gas.

Natural gas selling at anywhere from five cents to one dollar per thousand cubic feet[31] (depending upon the locality) has made the natural-gas engine an economical prime mover. Reliability of service is being insured by (1) the increasing complexity of the pipe-line network, thus making a supply independent of any one field; (2) by the construction of gas engines which can be easily converted into oil engines if the general gas supply should diminish; and (3) by the wider distribution of liquid butane in cylinders. The gas engines employed for generation of power and the operation of lineshafting are usually of the vertical type, three- or four-cylinder, and range on the average from 50 to 500 hp.

The engines used in the petroleum and gas industry alone are developing along rather highly specialized lines. The gas pipe lines, varying in size from 8 in. to 20 in. in diameter, with gas pressures ranging from 250 to 400 lb. per sq. in., usually employ gas-engine compressor sets of 750, 1000, or 1500 hp. These are mostly of the double-acting, twin-tandem, four-stroke type, with compressor cylinders placed on the opposite side of the crankshaft from the power cylinders.

During the past four years the practice of blowing oil wells has come into common use. This is a method of raising oil from deep wells by means of compressed natural gas. By this system high-pressure gas is introduced into the well through the space between the tubing and the casing, passes down to a point of proper submergence, displaces a column of gas and oil, and causes it to flow upward through the tubing and out of the well.

Many wells are blown with a gas pressure of approximately 250 lb. For starting a well to flowing a much higher pressure is required, sometimes as much as 1200 lb. This has made it necessary to design compressors which will work against pressures varying from 200 lb. to 1200 lb. The usual practice is to build the compressor for a working pressure of 250 lb. and to add clearance to unload the machine for the higher pressures.

The type of unit used for this work is a twin-cylinder gas engine, either two-stroke or four-stroke, of 160 to 225 hp. The reason for the popularity of these sizes is that a machine of that capacity is large enough to blow the average well and is not so heavy but it can be moved from one location to another without difficulty.

The four-stroke units are usually built with twin-horizontal single-acting power cylinders and a crosshead. The more common unit, however, is a two-stroke twin-cylinder horizontal unit built with single-acting power cylinders. These engines are usually equipped with an injection valve for introducing fuel gas under pressure into the power cylinders. This device is of recent origin and is successfully used by two of the larger engine builders.

The compressor cylinders are built in two stages and placed in line with the power cylinders but on the opposite side of the crankshaft, and are driven from the main crosshead by side rods from the main crosshead. On some of the four-stroke units, however, the compressor is driven by a second connecting rod operating from the main crankpin of the engine.

When oil wells are blown it is common practice to combine the blowing plant with a pressure system of gasoline extraction, and the whole process is known as "recycling." Dry gas from the gasoline plant passes into the well, mixes with the fluid, and absorbs a considerable amount of gasoline vapor; at the top of the well the mixture of gas and oil is separated, the gas going to the compressor plant where the gasoline is removed as in the regular pressure-gasoline system.

The pressure method of gasoline extraction is calling for engine-compressor sets to compress gas to about 250 lb. pressure in two stages. The absorption system of extraction requires the compression of gas to 30 to 40 lb. pressure. The engine-compressor sets used are similar to those that are used for well blowing.

"Repressuring" is the application of compressed air or gas to an old oil field. Compressed air or gas is pumped into the oil-bearing formation through an old well and displaces the oil, forcing it into adjacent wells. The compressor and engine used are of the same type as are used for blowing.

A large number of natural-gas engines are used for pumping oil wells. Wells in the older fields are pumped either by an engine located at each well in the case of deep wells, or by an engine operating a number of wells from a central plant in the case of shallower wells. The engines used for this work are horizontal two- or four-stroke, single-cylinder machines, and vary from 20 hp. up to 70 hp. per unit.

The work which pumping engines are called upon to perform is varied. When operating pumps they are run at low speeds and the load is seldom heavy. They are also used for hoisting rods and tubing from the well, at which times they are run at high speeds with a heavy load.

Engines for pumping service are equipped with reverse clutches and pulleys which are geared to operate at engine speed when going forward, and at twice engine speed in reverse.

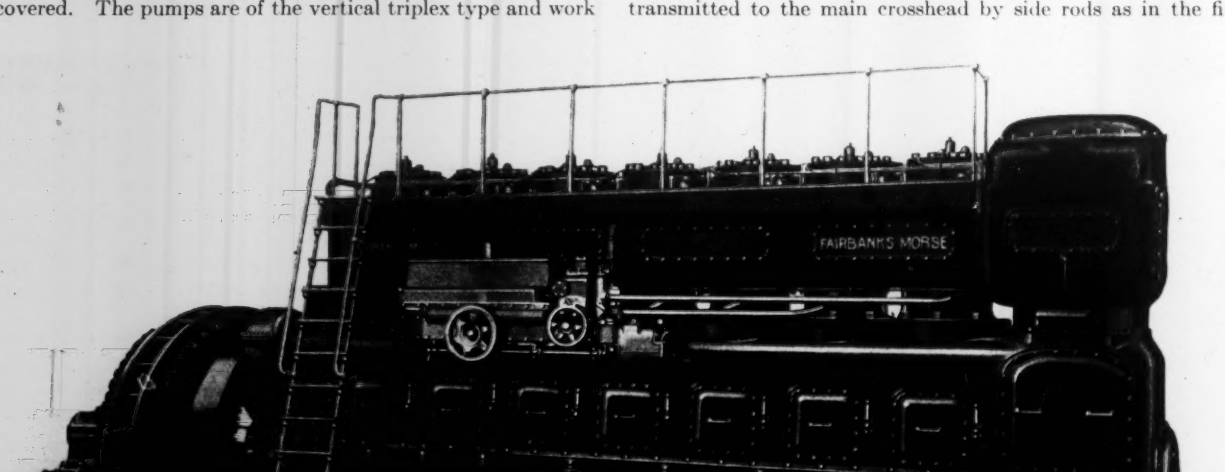
Another service that pumping engines perform is known as "swabbing," which is done when it is desired to raise a greater amount of fluid from a well than can be done by ordinary pumping methods. Swabbing consists of lowering a rubber swab into a well on the end of a cable. The swab passes down through the

fluid, and when at the proper depth is pulled up, bringing a column of oil to the surface. This service requires an engine to be operated at its maximum speed and power.

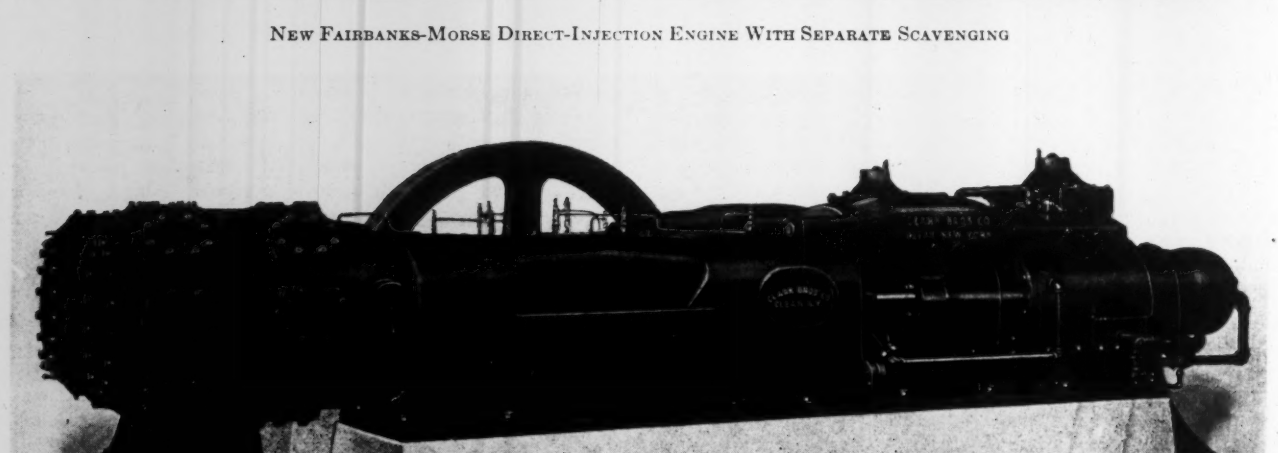
In the older fields in Pennsylvania and New York the water flood has come into common use. This consists of drilling wells into which water is pumped under pressure. These water wells are so packed that the water enters the oil-bearing sands and displaces the oil, forcing it into other wells from which it is recovered. The pumps are of the vertical triplex type and work against pressures from 50 to 500 lb., and are belt-driven from gas engines. The engines used for operating these pumps are horizontal two- or four-stroke units of from 30 to 60 hp.

Recently two new types of natural-gas-engine-driven compressor units have been put on the market. The first is a two-stroke engine, manufactured by Clark Bros. Co., of Olean, N. Y., with two single-acting power cylinders arranged in tandem but opposed to each other. Connecting the two cylinders is a third or scavenging cylinder in which works a double-acting piston. Each of the two power pistons are attached to the opposite faces of this piston. Two side rods transmit the power to the main crosshead of the engine. These engines are built as single units rated at 200 hp. or as twin units rated at 400 hp.

The second is a horizontal four-stroke twin engine and also has two opposed power cylinders on each side. The pistons of this unit are bolted to a common crosshead and the power is transmitted to the main crosshead by side rods as in the first unit. This engine is rated at 400 hp. and is manufactured by the Cooper-Bessemer Corporation of Mt. Vernon, Ohio.



New Fairbanks-Morse Direct-Injection Engine With Separate Scavenging



Clark Bros. Co. 400-Hp. Two-Cycle Gas-Engine Compressor

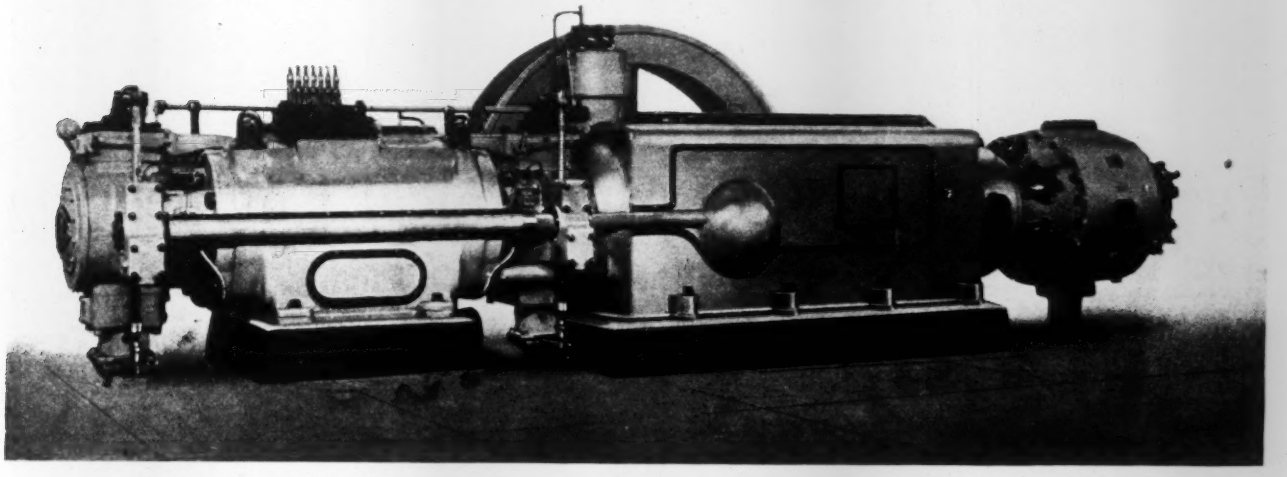
Blast-Furnace-Gas Power Progress

During the past year the Allis-Chalmers Company has placed in operation two of the largest gas engines ever built, i.e., 60-in. by 64-in. twin-tandem electric units, each of 6600 kw., and at the present time is building another similar unit as well as six

twin-tandem blowing engines, each having four double-acting gas cylinders 48 in. by 60 in. and two air cylinders each 82 in. by 60 in. having a capacity of 52,000 cu. ft. per min. at 20 lb. blast pressure.

The design of these engines follows in general that which has been previously used, but on account of the lower heat value (80 to 85 B.t.u. per cu. ft.) the compression has been increased to insure prompt ignition.

The greatest novelty in design consists in supporting both the gas and air cylinders on columns to allow for the free expansion of the engines longitudinally, thus relieving the foundations of any stress.



COOPER-BESSEMER 400-HP. HORIZONTAL FOUR-CYCLE TWIN ENGINE FOR NATURAL GAS

This design also adds to the convenience of operation by eliminating all foundations above the basement floor, thus giving free access to all of the lower portions of the machinery and permitting a better arrangement of the water, gas, and air piping.

The economy of these engines is such that the fuel gas required for blowing a given furnace with direct-connected compressors is only half that of a steam plant and for electric units about two-thirds of that required by a steam plant.

FOREIGN DEVELOPMENTS IN GAS POWER

Deutz reports a revival of the gas-engine program in Germany due to increased pipe-line facilities for the distribution of coke-oven gas. This manufacturer is making gas engines up to 1000 hp., these engines being so arranged that they can be converted to Deutz Diesel engines by the interchanging of a few parts.

M. J. REED, *Chairman* C. D. HOWARD
A. B. NEWELL MARION B. RICHARDSON
ROSWELL H. WARD C. G. SPRADO,
CARLTON KEMPER

Progress Report Committee, Oil and Gas Power Division.

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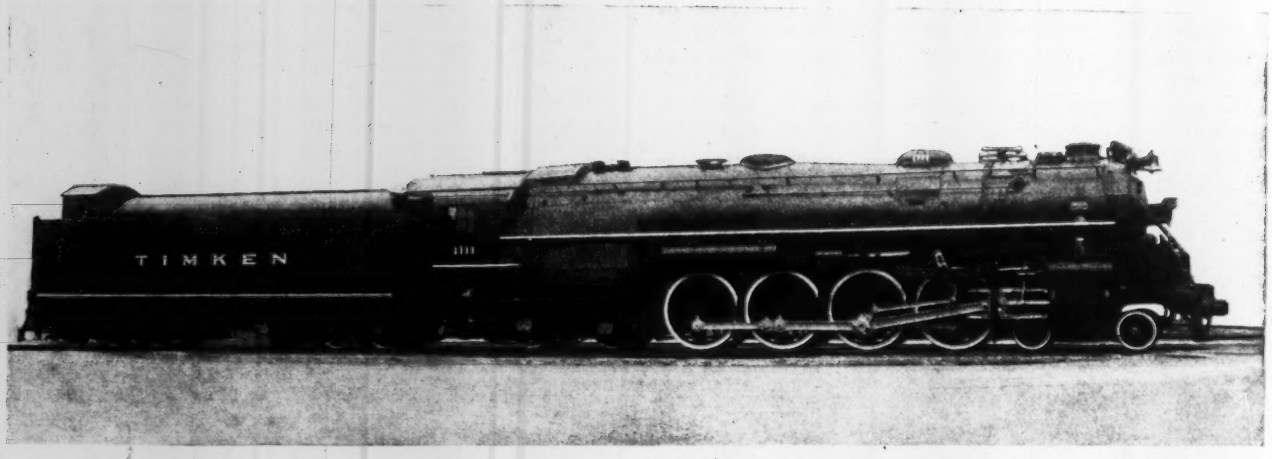

FIG. 1 TIMKEN 4–8–4 LOCOMOTIVE BUILT BY THE AMERICAN LOCOMOTIVE COMPANY. ALL JOURNAL BEARINGS ARE EQUIPPED WITH ROLLER BEARINGS

Progress in Railroad Mechanical Engineering

Contributed by the Railroad Division

Executive Committee: A. F. Stuebing, *Chairman*, P. D. Mallay, *Secretary*, J. B. Ennis, A. G. Trumbull, L. K. Sillcox, and Eliot Sumner

THE railroads have suffered during the year 1929 in a decrease in business, so that orders for new equipment have been materially less than in the years immediately preceding. However, the completion of orders under way has resulted in several designs of locomotives and cars being produced which are of particular interest.

STEAM LOCOMOTIVES

Probably the most conspicuous of these locomotives has been the Timken 4–8–4 type equipped on all axles with roller bearings (Fig. 1). This locomotive, which has cylinders 27 in. × 30 in. and drivers 73 in. in diameter, was built by the American Locomotive Company. At a boiler pressure of 250 lb., 264,000 lb. is carried on the drivers, giving a maximum tractive force, including the booster, of 76,500 lb. The grate area is 88.3 sq. ft. and the total evaporative and superheating surface, 7277 sq. ft.

The bearing housings of the engine truck and driving wheels are of one-piece steel castings extending across the locomotive between journals completely surrounding the axle. As the roller bearing provides full 360 deg. of bearing, the thrust of the piston is resisted by a full 180 deg. of bearing. Pedestal jaws are parallel. Alemite lubrication is provided which leads to all bearings and pins, including the roller bearing. The shell of the boiler, wrapper sheet, and firebox plates are of nickel steel. The frames are of nickel-vanadium, and nickel steel was used largely in the rods, crossheads, pistons, etc. The crankshaft and idler of the booster are equipped with Timken roller bearings. The valve motion has a maximum cut-off of 85 per cent, but the quadrant has a spring stop which normally limits the cut-off to 70 per cent.

The Chesapeake & Ohio Railroad brought out a 2–10–4-type freight locomotive built by the Lima Locomotive Company carrying 260 lb. steam and developing a maximum tractive effort of 91,500 lb., or, including booster, of 106,500 lb. The average weight on the drivers is 64,600 lb., and the cylinders are 29 in. × 34 in.

High-pressure locomotives are steadily attracting more attention. The Delaware & Hudson Company has put in service this year its third high-pressure locomotive. The first, constructed several years ago, carried 350 lb. boiler pressure, and the second, 400 lb. The last one, the *James Archbald*, carrying 500 lb. steam pressure, has compound cylinders $20^1/_2$ in. and $35^1/_2$ in. × 32 in. The weight on the drivers is 300,000 lb., giving a tractive effort of 84,300 lb.

The New York Central is having a multi-pressure 3-cylinder locomotive, 4–8–4 type, built by the American Locomotive Company. This locomotive will carry a pressure of 1400 lb. in the closed circuit contained in the water-tube system surrounding the firebox. Eight hundred pounds steam pressure is carried in the secondary system actuating two high-pressure cylinders, and 250 lb. actuating one central low-pressure cylinder. The outside cylinders drive the third pair of driving wheels, and the inside cylinder the second pair. The Canadian Pacific Railway is building at its Angus shops a locomotive with similar boiler and cylinder arrangement, but having a 2–10–4 wheel arrangement.

The London and North Eastern has put in service a high-pressure locomotive carrying 450 lb. steam pressure, fitted with a Yarrow-type boiler. This locomotive is a 4-cylinder compound, the wheel arrangement being of the 4–6–4 type. The German State Railways have built three Schmidt high-pressure, double-pressure-design steam locomotives, one of the high-pressure being of the Löffler system. The Schwartzkopff Löffler locomotive was built by the Berlin Maschinenbau Aktien Gesellschaft and is a 3-cylinder compound of the 4–6–2 type with an estimated tractive effort of 37,000 lb. The outside high-pressure cylinders operate on 1700 lb. pressure and the inside cylinder on 213.35 lb. The drivers are 78.7 in. in diameter, and the weight on the drivers

is 132,240 lb. The combined heating surface is 2960.19 sq. ft. The high-pressure saturated steam is pumped through water tubes surrounding the firebox, raising the temperature to 843 deg. fahr. Approximately one-fourth of the volume of the high-pressure steam is led to the high-pressure cylinders. The remainder flows through the high-pressure evaporator, passing through a perforated pipe which evaporates the water as it gives up its superheat. The circulating pump draws off the saturated steam, pumping it through the firebox tubes, completing the cycle. The high-pressure cylinders exhaust at 256 lb. into an oil separator and then pass through a heat exchanger which consists of a low-pressure boiler. The exhaust steam condenses as it passes through the tubes, and the condensate is pumped through the high-pressure steam evaporator. Steam generated in the heat exchanger is superheated to 572 deg. in a low-pressure heater, from which it is led to the low-pressure cylinder. It has been estimated, theoretically, that the locomotive will save 47 per cent in fuel compared to modern locomotives of similar type.

The Krupp-Zoelly turbine locomotive, driving through a jackshaft, has been redesigned and is now in service on the German State Railways.

Internal-Combustion Locomotives

The low cost of fuel for oil engines for locomotives and rail cars is continually stimulating the development of such engines. The Westinghouse Electric & Manufacturing Company has built two oil-electric locomotives, each mounted on 4-wheel trucks, the smaller one having one 400-hp. oil engine driving an electric generator, and the other having two 400-hp. engine generators, in each case driving 4 motors mounted on the trucks. The maximum tractive effort of the smaller unit is 42,000 lb. and of the larger, 66,000 lb. The smaller locomotive contains a raised operating cab at one end with control equipment on each side. The larger locomotive contains a raised operating cab in the center. These locomotives were designed primarily for shifting service, but can also operate up to 40 miles per hour. The H. K. Porter Company has also built a locomotive mounted on two 4-wheel trucks for shifting service, equipped with two Buda-Man 6-cylinder 175-hp. engines. The General Electric Company has also built a locomotive with Buda engines designed to burn distillate, and the Ingersoll-Rand Company has brought out a locomotive of larger power mounted on two 4-wheel trucks. The New York Central has had in operation for over a year (and has recently placed an order for additional ones) locomotives of the 3-power design to operate on direct current from the third rail, by gas-electric generator, and for short periods by storage battery. Each of these locomotives is equipped with an Ingersoll-Rand 300-hp. oil engine which drives a 200-kw. generator. These locomotives have successfully met the requirements for extending runs from electrified territory to lines that are not electrified, and for switching on industrial sidings that are not electrified.

Late in 1929 the first Diesel-compressed-air locomotive, built for the German State Railways, was given an actual road test. This locomotive consists of a vertical six-cylinder 1000-hp. Diesel engine, 450 r.p.m., with airless injection, direct-connected to a two-cylinder air compressor of the single-stage, double-acting type. Air is compressed to 100 lb. pressure. Compressed air is conducted into a counterflow heater in which it is heated to a temperature of 680 deg. fahr. by the exhaust gases of the Diesel engine. From there it flows through a regulating valve to two locomotive cylinders, applying power in similar manner to a steam locomotive through main and side rods to three pairs of coupled drivers. The wheel arrangement is 4–6–4.

Electrification

During the year, electrification of the suburban lines of the Delaware, Lackawanna & Western Railroad for multiple-unit operation by 3000-volt direct current has been put in service on 70 miles of road between Hoboken and Montclair, Morristown, Dover, Bernardsville, and Gladstone. The Pennsylvania Railroad has extended its suburban electrification between Philadelphia and Trenton and Norristown, an addition of 43 miles of road operating on 11,000-volt alternating current. The Reading Railway is electrifying its suburban lines in the immediate vicinity of Philadelphia, covering 50 miles of road and operating on 11,000-volt alternating current, which, however, will not be put into operation in 1930.

The new Cleveland terminal was opened for partial electric operation during the year, covering 17 miles of road and operating on 3000-volt direct current. Twenty-two electric locomotives will be required for the complete operation. The wheel arrangement is 4–6 + 6–4. The six driving axles are gear driven by six motors, giving a total one-hour rating of 3030 hp. and a tractive effort of 75,000 lb.

The Pennsylvania has put in service four electric locomotives, 4–4–4 type, designed for through passenger service, and they are now being tested on the electrified portion of the line between Trenton and Wilmington. These locomotives have two pairs of driving wheels, each gear-driven by two 500-hp. motors. In Europe the Paris, Lyons, and Mediterranean Railway has built heavy locomotives for operating on grades of from 2 to 3 per cent on the Mont Cenis line on 1500-volt direct current. These locomotives, of the 4–6 + 6–4 type, have a maximum hourly rating of 5300 hp. at 50 miles per hour and a tractive force of 40,000 lb. The continuous rating is 4120 hp.

Again the front-end design of locomotive boilers has attracted much attention, the object being to reduce back pressure. The relation of draft to back pressure is a measure of the draft-producing efficiency, and this efficiency is a reliable indication of the relative values of different nozzles and stacks. These experiments show that the multi-point nozzles of larger area will produce the same draft as the plain nozzles with less back pressure, and that the drawbar pull is increased, but no gain in engine efficiency can be observed at the rates of ordinary road operation.

Very encouraging results have been obtained from experiments in grate designs to reduce clinker and ash with various grades of coal, thus reducing the stops for fire and ashpan cleaning which have been necessary on long locomotive runs. One grate has been designed to burn 1¼-in. screenings, or slightly smaller than run-of-mine coal, with a minimum loss of coal through the grates.

Cars

One of the most noteworthy developments in passenger cars has been the air-conditioning system designed by the Carrier Engineering Corporation. The B. & O. dining car *Martha Washington* with this system has been in service since April, 1930. During the tests the temperature has been reduced from 92 deg. fahr. to 70 deg. in 20 minutes. The object of the system is to free the air of dust, soot, cinders, and other foreign matter, and to control the temperature and humidity within limits.

Mechanical filters are provided on the roof line. The incoming air passes through cooling coils, reducing the temperature, and the excess humidity is eliminated from the air, after which motor fans distribute it to the car body through louvres in the half-deck. When the temperature in the car reaches a predetermined point, 10 or 15 deg. below the outside air, a temperature regulator shuts off the admission of outside air and the air within the car is recirculated without passing over the cooling coils. The temperature regulator will function within a range of 5 deg. Make-up water must be added to replace the evaporation, which amounts to a maximum of 10 or 12 gallons per day.

The Atchison, Topeka & Santa Fe Railroad also has equipped

its dining car *Chief* with a similar air-conditioning system, and under test with the car loaded with passengers and the outside temperature at 104 deg., the temperature in the body of the car was maintained at 72 deg.

The Safety Refrigeration, Inc., have developed an iceless refrigerator and heater car on which tests were conducted between the State of Washington and New York City. The outside temperature varied between 6 and 50 deg. The temperature of the fruit in the car was held between 31 and 33 deg. for 13 days. The temperature is controlled by two thermostats. One of these consists of a responsive bulb mounted near the ceiling, while the other has a bulb so located that it is affected only by atmospheric temperatures. The first is operated in conjunction with the control apparatus located in the adsorber compartment, and

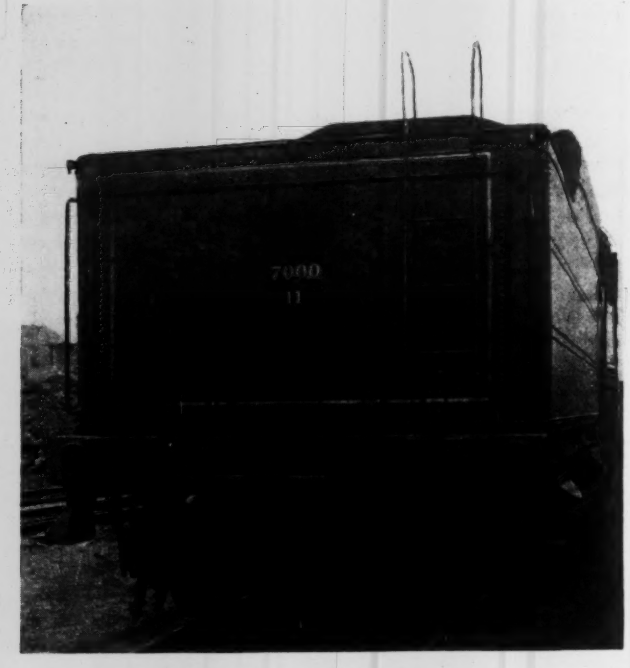

FIG. 2 APPLICATION OF O-B TIGHT-LOCK COUPLER TO TENDER OF LOCOMOTIVE

controls the refrigeration by cutting off the flow of gas to the silica gel adsorbing apparatus when the car temperature has reached the prescribed temperature. The silica gel refrigerating system consists of three main parts: the adsorber containing the silica gel, the evaporator, and the condenser. It is operated by alternately lighting and extinguishing gas burners at proper intervals.

Electrical refrigeration has increased the size of refrigerating units, ice boxes, and coolers in separate units requiring the duplication of the original generator and battery and increasing the size of both units. Eight railroads are experimenting on dining and business cars.

The Baltimore & Ohio Railroad has been testing the O-B tight-lock coupler (Fig. 2) in passenger-train service. These tests were conducted primarily to develop an automatic tight-lock coupler which could be used satisfactorily with connections for steam, air-brake, air-signal, and electric systems. It was desired to combine all these connections between cars in one structure so that when the car couplers were unlocked, the valves in the steam and air lines would close automatically and at the same time open the electric circuits. It was desired to supply a continuous source of electric energy from a central generating unit in sufficient quantity to provide for the operation of the air-conditioning equipment, electric refrigeration, vacuum cleaners, hot-water heaters, cigar lighters, window-operating devices, coffee percolators, and other devices. The generator consists of a 60-cycle, 220-volt alternating-current steam turbo-generator of 25 kw., mounted on the front of the locomotive.

Since the American Railway Association, Mechanical Section, has formulated a set of specifications for draft gears, definite progress has been made toward the construction of gears which will more nearly meet all of the essential requirements of service. Further tests are being conducted under the auspices of the American Railway Association.

Two special designs of continuous draft gear have been developed with the object of distributing the push-and-pull shocks directly through the train instead of the general practice by which the shock is transmitted from the draft gear to the car body and thence through the gear on the opposite end to the next car, and so on. The Duryea design consists of center sills with draft gear at each end, mounted and guided within the underframe of the car but free to move longitudinally and connected to the car body by two cushion gears located behind the bolsters. Shocks are therefore transmitted through the center-sill column directly to the next car. A large number of Duryea underframe cars are now in service on the Baltimore & Ohio and the New York Central.

The Alma draft gear is also of the continuous type, but of different construction. The shocks are transmitted through a rod or shaft carried on guides mounted between the center sills. The rods from each end of the car are connected together through conical draft springs, and the rods are connected to the center sills through conical springs. One hundred and twenty-five freight cars and twelve passenger cars on the Pennsylvania are equipped with this draft gear.

Service tests of the continuous draft arrangements, as well as the draft gears themselves, are being watched very closely by the railroads with the object of reducing claims for loss and damage to lading.

AIR BRAKES

Following the air-brake investigation which was conducted by the Interstate Commerce Commission, a report was made in 1924 stating that improvements in power brakes were necessary and must be made. The American Railway Association agreed with the Interstate Commerce Commission to make a thorough and unbiased investigation to determine what improvements were necessary or desirable. Tests were made on the Purdue test rack, which indicated the desirability of carrying out road tests before definite conclusions could be reached. These tests have been under way for over a year on the Southern Pacific Railway. This railroad was selected as the one offering conditions of heavy mountain grade and of long moderate grade and level road between San Francisco and Portland, Ore.

The principal tests have been made with the Westinghouse improved equipment, FC-5 and FC-3, under varying conditions which must be met in normal railroad operation. The tests have become much more elaborate than was first anticipated, and it has not been possible, as yet, to issue an authoritative report of the conclusions reached.

MOTOR COACHES AND RAIL CARS

The popularity of motor-coach travel is increasing, and the railroads and subsidiary corporations have linked together short coach routes and combined rail and motor-coach service to a marked degree. Bus stations have been established at or near railroad stations to provide ready transfer between rail and bus. Generally speaking, in sections of dense population the railroads have provided bus routes radiating from large cities, and in many

cases paralleling railroads between cities. Over long distances combined rail and motor-coach service is offered by coach during the day and by rail at night. Railroads operated 300 motor coaches in 1925, and 2389 in 1929. Motor-coach schedules are, generally speaking, twice as long as by rail, and regular fares are from 20 to 50 per cent less.

Rail cars have been generally accepted as the most satisfactory units for lines of light traffic, and while the number of cars built has not increased in the last year, attention has been devoted to the design of cars of larger power to haul one or more trailers and to reducing the cost of fuel. Engines of 400 hp. in single units and also two units of 300 hp. each have been built in recent designs for oil and gasoline fuel.

The Climax Engineering Company has brought out an 8-cylinder engine for use on rail cars, designed to burn distillate of 36 to 40 deg. B., costing one-half as much as gasoline. The engine has a 6-in. × 7-in. cylinder and develops 200 hp. at 1000 r.p.m.

The use of roller bearings is increasing to a marked degree on railroads. A large number of new freight as well as passenger cars are being equipped. The Delaware, Lackawanna & Western Railroad has equipped 131 multiple-unit electric cars. The North Coast Limited of the Northern Pacific Railway has been provided with roller-bearing equipment for its seven trains, the dining and sleeping cars having American Steel Foundries axle-unit roller bearings and Hyatt roller bearings. The Pennsylvania Railroad has equipped one hundred 70-ton hopper cars on which resistance tests will be run under varying conditions of temperature, grade, and speed. The Pennsylvania Railroad, including the Long Island Railroad, has equipped 144 multiple-unit electric cars with roller bearings. The New Haven has equipped 15 new baggage and mail cars.

The use of roller bearings on locomotives is being extended to engine truck wheels, tender truck wheels, and in a few instances to driving wheels. The Timken locomotive was equipped on all axles, engine and tender. A Delaware & Hudson consolidation locomotive is equipped on the driving wheels. New York Central Hudson-type locomotives are equipped on the engine truck wheels. The Pennsylvania electric locomotives are equipped on all axles with roller bearings.

The desire to provide a design of freight container and container cars which will give the necessary flexibility of operation between railroads and for transfer between cars and motor trucks so as to complete the movement from consignor to consignee, has brought out a great variety of designs and patented accessories. Present operation is therefore restricted by the variety of equipment and freight-station facilities. These designs must be reduced to common standards for interchangeability to encourage the general use of containers upon a basis economical both to the railroad and the shipper, and so that the railroads can compete with the road haul by motor truck and regain the traffic which they have been losing.

General Economic Condition

The railways have suffered through a loss of traffic during the present business depression, and this has been considerably greater than was anticipated earlier in the year.

The railways started the year in excellent physical and operating condition. Anticipating a loss of traffic over a comparatively short period, arrangements were made to continue much of the improvement work that was under way. The decline in car loadings has increased week after week, amounting in September to more than 20 per cent below the same month of last year. The latest reports available show a 15 per cent reduction. Within recent months sharp retrenchments became necessary. The number of railway employees in August was 245,000 less than in the same month of 1929.

The railways now have a well-perfected transportation system, ready to handle a much larger traffic than is offered. Meanwhile the highways and waterways are diverting increasing amounts of traffic from them, and the Government is carrying out a program of extensive development of inland waterways to "relieve" the railways. It is largely owing to this diversion of traffic that the railways have been reducing the number of their employees.

Progress in Steam-Power Engineering

Contributed by the Power Division

Executive Committee: V. M. Frost, *Chairman*, C. S. Gladden, *Secretary*, F. M. Gibson, W. F. Ryan, and Alfred Iddles

THE steam-engineering profession is to be congratulated on the vision displayed and on the excellent work performed by the Individual Committee on Stationary Steam-Generating Units, a Subcommittee of the Main Committee on Power Test Codes, in the formulation of the recently revised Boiler Test Code. The introduction of rational fundamental measures for boiler output and rating, doing away with the irrational boiler horsepower and percentage rating, constitutes an important improvement. It may be observed that manufacturers, in their advertising and in other ways, might well assist in the adoption of the new methods of expressing boiler size and output, instead of continuing to use the older units.

Plant Investment Costs

The great desirability of reducing steam-plant investment costs is continually borne in on the designing engineer, particularly since, as has recently been brought out by M. S. Sloan and others at association meetings, the investment in power systems per unit of capacity and of earnings is increasing.

A not inconsiderable saving may be effected by simplifying the power-station building and other structures. The character of the building is, of course, dictated to some extent by the surroundings, somewhat more substantial and possibly ornamental construction being called for by a metropolitan station than by an outlying power plant. A moderate-size station was built recently, using a relatively light steel frame and asbestos sheeting for both roof and sides; the building presented a good appearance and carried a low cost. Other advantages of such a structure are that it can be purchased promptly and erected rapidly, and that equipment installation can readily and safely

begin before completion of the building; in this case the first turbine was turning over within six months of the beginning of construction.

It is obvious that the increase in size of turbine and boiler units tends toward a lower unit cost of steam plants, and this has been observed in recent large stations.

A considerable economy can sometimes be effected in the first cost of a plant by the elimination of all refinements that do not generously pay for themselves throughout the life of the plant. Each engineer must of course evaluate the weighted-average capacity factor under which the plant will run, but it is believed that, in many cases, this is assumed higher than will actually be the case. Data published in the engineering press during the last few years, including the record of actual capacity factors of turbines and other equipment for a considerable term of years, indicate that this factor may be well under 50 per cent or even under 40 per cent for the useful life, instead of the values of between 50 and 75 per cent frequently employed in working out economics as to choice of equipment. The assumption of a relatively low capacity factor will, of course, tend toward the choice of the simpler and lower-priced station.

Relations Between Industrials and Utilities

A number of papers presented by the Industrial Power Section of the Power Division discusses the relation of industrials and utilities. This matter is becoming of increasing importance, and utility engineers should therefore, so far as may be practicable, understand the business and the processes of the industrial enterprises in order to be able to look forward and promote methods of cooperation that will be profitable to both interests. Such cooperation will sometimes mean the construction by the utility of power plants adjacent to the industrials, such as the Deepwater (N. J.) and Baton Rouge (La.) stations, to furnish process steam or other form of heat and at the same time by-product electrical energy for the use of the industrial and the utility. It will be to the best interests both of industrials and utilities to make a thorough study of possible cooperation. Under present conditions, the industrials are sometimes glad to limit their capital expenditures to the construction necessary for their own business, letting the utility supply the power facilities.

Employee Relations

There is continual slow progress in the safety campaign in steam power plants, but there is yet some distance to go. In addition to safeguarding the employee from injury, attention should be given to proper ventilation, to reasonable air-temperature control, and to cleanliness. Attention should also be given to the reduction of noise and other elements tending to confusion—study and understanding of the deleterious effects of noise are in the elementary stage only. Such measures will tend toward a reduction in the total cost of operation, and will therefore benefit the plant owners.

Likewise executives and engineers should organize the plants and systems so that not only the safety and comfort but the development of the employee shall be fostered. It should not be assumed that net profits are the only object of the industry: an important aim should be the development of the individuals serving and operating the industry. The implications of "service"—so much discussed with respect to the customer—should be turned inward and be considered in connection with the development of the company personnel. Many of the large industrial and utility companies have provided for stock purchase, savings, retirement pensions, education, and for other means of assisting their employees. To insure the continuance of such assistance, trust funds have sometimes been provided to eliminate the effects of lean years and of changes in executive policy.

General Progress

The past year has witnessed a steady improvement in steam-power engineering, resulting, in no small measure, from the continued cooperation between manufacturers and designing and operating engineers, as well as from the pooling of information through the media of the A.S.M.E. and other national organizations.

In the A.S.M.E. Transaction, Paper FSP-51-54, "Progress in Steam-Power Engineering," Sept.-Dec., 1929, a résumé was given of certain objectives attained at that time. Reviewing these in the order in which they were given, it is found that since 1929:

1 There has been no radical change in the types of fuel-preparation and -burning equipment available.

2 Flexibility of fuel-preparation and -burning equipment has improved, permitting the burning of different fuels and of varying grades in the same furnace, particularly in connection with combinations of oil and gas fuels.

3 Fuel-burning equipment, boilers, and boiler accessories have been made available that permit an output of 1,000,000 to 1,500,000 lb. of steam per hour from a single generating unit. Two units at the New York East River Station have shown maximum output capacities of about one and a quarter million pounds each.

4 The single-shaft turbine unit of 160,000 kw. at the East River Station and the cross-compound unit of 208,000 kw. at the State Line Station are still the largest of these types.

5 A considerable increase has been noted in the use of steam pressures of from 1200 to 1400 lb. Several plants using 800- to 850-deg. fahr. steam are under way, and one company is installing an experimental turbine to operate up to 1000 deg. fahr.; the superheater will be subjected to a temperature not far from 1100 deg. fahr., KA-2 alloy steel being used.

6 Equipment is being refined for the reheating of steam after partial expansion in the turbine, using either flue gases or high-pressure steam as the heating medium.

7 There has been no marked improvement in methods of regenerative heating of feedwater.

8 Furnace water-wall construction, largely to the exclusion of refractories, has been used for practically all high-capacity boilers.

9 No important improvements have been made in condensing equipment.

10 Economizers and air heaters have been refined, to reduce initial investment and maintenance expense.

11 The mercury-vapor steam cycle has shown good progress over the development attained in 1929.

12 Combustion-control equipment has become increasingly popular in assisting operation to approach test efficiencies.

13 There has been no marked progress in reducing make-up-water percentage since 1929.

14 Various refinements have been made in coal- and ash-handling equipment, but nothing of an extraordinary nature.

Boiler Equipment

Advances have been made in thermal efficiency, and it is noteworthy that progress has also been made in reduction of investment costs. The cost of large-capacity units per unit of output decreases with increase of size of boilers, especially when the auxiliary equipment and building space are considered. The availability factor of steam-generating units is of necessity receiving more and more attention with the wide adoption of high-capacity units. The need for large boiler units is emphasized by the growing tendency toward large turbine-generator units.

For some time steam temperatures have in this country been limited to a maximum of approximately 750 deg. fahr. There is, as above indicated, a present tendency to higher temperatures, and superheater manufacturers will guarantee their equipment for temperatures up to 850 deg. fahr.; some of these manufacturers recommend 0.3 to 0.4 per cent carbon steel for such superheater tubes, feeling it unnecessary to go to high-priced alloys for this service.

In one new boiler design, steam is taken from the steam drum to the superheater by means of a considerable number of tubes expanded into the steam drum and the inlet superheater header along practically their entire length. This arrangement eliminates the old-style internal dry pipe, and does away with the necessity of longitudinal flow of steam within the boiler drum; it also contributes to equal distribution of steam in the superheater header; practically all of the friction drop through the superheaters is in the tubes, obviating the necessity of ferrules or other means of obtaining even distribution.

Increased use is being made of steaming economizers, particularly in high-pressure installations, one advantage being the substitution of lower-cost heating surface for the higher-cost boiler heating surface. The exit-gas temperatures resulting from the high pressures now used, and the high boiler outputs obtained, call for the use of an economizer between the boiler and air heater, the boiler exit gas carrying too high a temperature for the air heater.

Increased production from new fields in California, Oklahoma, and Texas, together with great improvement in distribution facilities, has stimulated a large-scale use of both natural gas and oil in both the industrial and public-utility field. These fuels are now available over a large portion of the United States. As it is seldom feasible to store a sufficient quantity of gas to assure uninterrupted service, combination oil and gas burners are usually installed in gas-burning plants, with a reserve supply of oil fuel. About 100,000 miles of oil and 57,000 miles of natural-gas pipe lines are in service. At present, public-utility power plants use only about two per cent of the crude oil produced.

Progress is being made in the adaptation of the unit system of burning pulverized coal. This is in part the result of an endeavor to cut initial investment cost, the unit system being generally cheaper than the storage or bin system. It is reported by the N.E.L.A. that the number of unit systems planned for 1930 was over three times that of the storage systems. A careful comparative test at the Calumet Station in Chicago showed practically equal efficiencies and operating costs for the unit system and the bin system; this trial was described in a paper presented by A. E. Grunert at the Detroit meeting of the A.S.M.E. in June, 1930.

Experimentation and research are being conducted to reduce costs of operation and improve performance along the lines of lubrication, of drying the coal in the mill rather than in separate driers, and of improvement in venting methods.

The load range of pulverized-coal burners, as well as of oil and gas burners, with satisfactory operation, is still undesirably limited. A high percentage reduction from maximum boiler output may mean either damage to burners from overheating, or a reduction of boiler efficiency resulting from cooling air put through idle burners.

Progress is noted in the installation of equipment to reduce the discharge of ash and cinders from stacks, and of coal dust from cyclone and bin vents. However, although a limited number of more or less satisfactory methods are available for reducing the ash-discharge nuisance, there is not as yet any moderately priced and thoroughly effective means of combating this problem; the cost of the most effective installations is very high. The use of slag-tap bottoms in pulverized-coal-fired furnaces is slightly increasing as difficulties are being overcome; this type of ash removal reduces the percentage discharged from the chimney.

Instruments have been developed to assist in the elimination of smoke and in automatic plant control. Methods in use for observing smoke density include automatic photography, and the projection of a light beam through gas passages for visual observation or automatic recording of the light intensity by means of photoelectric cells. More attention is being given to the interrelation of instrument arrangement and apparatus control by centralizing the grouping of instruments to facilitate supervision of equipment.

TURBINES

The N.E.L.A. reports that the average size of units installed in public-utility plants increased from about 42,000 kw. in 1928 to 65,000 in 1929, a rise of over 50 per cent.

Aside from periodic inspection and adjustment, troubles incident to turbine blading still constitute the greatest single cause of turbine outage; these troubles are, however, being reduced.

The chief developments during the year have been the initial operation of stations designed exclusively for 1200 lb. steam pressure, the removal of the 750-deg. fahr. limit on initial steam temperature, and the introduction of vertical compound and triple-tandem compound turbines. The vertical compound turbine-generators for 1200 lb. pressure range from 25,000 to 110,000 kw., and the triple-tandem compound units up to 150,000 kw. in size.

HIGHER STEAM PRESSURES AND TEMPERATURES

In the 500- to 800-lb. pressure range, installations for public utilities have been principally in the nature of additions to plants already in existence. This range of pressures also finds service in industrial companies needing large amounts of process steam.

Pressures of 1200 to 1300 lb. have been the most popular in the higher-pressure range. The Deepwater, Holland, and South Amboy stations went into initial operation during 1930.

The list given below includes stations using pressures of about 1200 to 1300 lb., either operating or under construction.

Station	Company	Inlet pressure, lb. per sq. in.	Exhaust pressure, lb. per sq. in.	Turbine-generator, kw.
Edgar	Edison Electric Ill. Co. of Boston	1200	360	1– 3,150
		1200	360	1– 10,000
		1200	360	1– 12,500
Lakeside	Milwaukee Electric Ry. & Light Co.	1200	300	1– 7,000
Port Washington		1230	...	1– 80,000[1]
Northeast	Kansas City Power & Light Co.	1200	315	1– 10,000
Holland	Penn-New Jersey Power System	1250	400	1– 12,000
Deepwater, N. J.	United Gas Imp. Co. and Am. Gas & Elec. Co.	1200	400	1– 12,500
		1200	400	2– 11,150
South Amboy	Jersey Central Power & Light Co.	1250	...	2– 25,000[1]
Deepwater, Tex.	Houston Lighting & Power Co.	1280	360	1– 12,000
Station A	Pacific Gas & Elec. Co.	1200	...	2– 50,000[1]
Station B	San Antonio Public Service Co.	1250	175	1– 7,610
River Rouge	Ford Motor Co.	1200	...	1–110,000[1]
State Line	State Line Generating Co.	1300	...	1–150,000[1]
		1300	...	1–125,000[1]

[1] Includes low-pressure elements.

POWER-STATION ECONOMY

Some excellent records in power-station operation have been made during the past year or so. The following paragraphs cite a number of outstanding cases in the various pressure and

steam-cycle classes; nominal figures are given for steam pressures and temperatures, without attempting to include closely accurate data or to indicate which case represents the best performance.

Long Beach (California) Station No. 3 is a 400-lb. 725-deg. fahr. plant, working on the regenerative cycle, burning natural gas as a fuel; with one 100,000-kw. machine running at 90 per cent machine factor, it averaged 12,850 B.t.u. per kw-hr. net output for the year 1929, with a best-day performance of 12,550. Another station, burning 13,900-B.t.u. bituminous coal on underfeed stokers, and with steam pressure and temperature slightly under the above, working under an annual load factor of 65 per cent, has averaged 13,700 B.t.u. per kw-hr. net output for yearly periods, with one month as low as 13,000.

The Columbia (Ohio) plant, burning 13,900-B.t.u. coal in the powdered form, with steam conditions of 600 lb. and 725 deg. fahr., working on the reheat cycle, has shown a consumption of 12,500 B.t.u. per kw-hr. net output for one month. The Powerton (Illinois) station, with the same steam conditions and steam cycle, burning 10,000-B.t.u. pulverized coal, consumed 12,450 B.t.u. per kw-hr. net output for one month and averaged 12,550 over a four-month period.

LOUIS ELLIOTT.
Progress Report Committee, Power Division.

Progress in Textile Engineering

Contributed by the Textile Division

Executive Committee: Henry M. Burke, *Chairman*, McRae Parker, *Vice-Chairman*, William L. Conrad, *Secretary*, Earle R. Stall, Paul A. Merriam, and H. V. W. Scott

AS A RESULT of depressed business conditions in all fields and particularly in textiles during the year that has passed since the filing of the 1929 report, there has not been much desire on the part of mill men to introduce new equipment. The foremost consideration of mill managements has been to conserve their cash, or at least to make it last as long as possible. Furthermore, since mill men have finally had it impressed upon them that the real difficulty in textiles is "too much plant," or in other words, too many in the business, there have been few if any important new plants built during the year.

It cannot be said that this condition of "too much plant" has been the result of any particularly active expansion during the past few years, since the rate of spindle increase has not been rapid for some time. It is rather, we feel, the result of improved methods of production, combined with the gradual adoption of improved equipment that has during the past few years greatly increased the unit production of both employee and plant. It is this increased efficiency, so much in evidence since the war, that has culminated in a condition of overproduction, and our industry has had to hold up until demand can catch up.

As pointed out in the progress reports of both 1928 and 1929, there had been an increasing demand for engineers and technical men by the industry. Apparently these very engineers and technical men, by bringing increased efficiency to the industry, have been a factor in the present overproduction that has caused this slump. What is most needed now is a different kind of engineering: management or executive engineering that can keep production within bounds and maintain prices where they should be.

MILL BUILDINGS

With the industry thus stagnant as far as plant increase is involved, mill engineers and architects have had little opportunity to demonstrate progress. Consequently there have been no radical changes or developments in mill construction. In general the existing types of construction that have been developed during the last few years are still considered to represent progressive engineering. These present types are the result of careful thought and logical developments which have taken place with changing conditions. When there was an abundant supply of long-leaf-pine timber at low cost, and good quality of brick could be had and laid at a cheap price, there was little to decide as to the selection of materials for mill buildings. Consequently slow-burning or mill-type construction, comprising brick walls, wood sash, wood columns, hard-pine floors, and long-leaf-pine timbers, was considered standard. At that time reinforced-concrete and steel construction were much costlier than the slow-burning type. Later, however, long-leaf-pine timbers became scarce, and serious consideration was given to other types of construction. The design of reinforced concrete became more standard and simplified, and building contractors became familiar with it, and in many cases it was found that the more stable floor construction was economical, even though the cost was higher.

Likewise steel construction became more common for cotton-mill work, and in late years steel beams have been used in many plants. Brick or concrete walls, with a maximum of steel-window-sash area, steel beams, and hard-pine floor plank, give a rigid and strong floor and permit the spacing of columns far enough apart to accommodate the machines and their proper working alleys. This type of construction is rigid enough to eliminate vibration or deflection of the floors. The greater ceiling heights, with the large window areas, give well-lighted and properly ventilated interiors that are attractive and in which the working conditions are the best.

The standardization of many building products has been further perfected, as, for example, steel sash; also, the steel concerns are now furnishing a much greater variety of shapes, and consequently it is possible to select, at economical cost, almost any desired depth and weight of steel I-beam or channel which formerly would have been considered special. Substantial developments have been made in methods and cost of treating floor and roof planking to resist dry rot, and in insulation of roofs to prevent ceiling drip in rooms of high humidity. Heat-absorbing and light-diffusing glass is now obtainable at reasonable prices.

Progress has been made in the plumbing and sanitary con-

ditions in the mills, and modern electric-refrigerated drinking-water systems have become more generally regarded as standard equipment.

TEXTILE-MACHINERY PRODUCERS

Textile-machinery manufacturers are comparatively idle, and hence with time on their hands for perfecting new ideas. Furthermore, progressive mill men are striving to bring about improvements in quality and fabrics, and are demanding performances never before attempted. Thus spurred on, the machinery manufacturers have brought out a number of improvements, all of which either reduce the cost of production or meet the demands of new fabrics. In fact, the only chance they have at present to sell equipment is when the mill men are convinced that such equipment will make itself felt in the sale of their product, either by reducing the cost of a given fabric or by making it possible to produce something newer and better. There are few sales of equipment for expansion only.

WOOLEN MACHINERY

Some of the outstanding developments in woolen machinery are as follows: Woolen cards have been developed employing more cylinders in a single card, with an increased production and an improved quality of roving. There is a decided trend toward the adoption of the center-draw, broad-band type of feed. In fact, all three of the larger manufacturers are presenting a feed of this type in present machines. A card-stripping device of the vacuum type has been developed for both woolen and worsted cards. Heretofore this equipment was confined to cotton cards. New reciprocating table feeds and improved squeeze rolls have provided better preparation of the stock.

There has been a growing popularity and adoption of frame spinning of woolen yarns, and this has put the manufacturers of mules on their mettle so that we see a marked development toward longer mules of a wide gage for both woolen and carpet yarns. In some cases the capacity of mules has been increased as much as 50 per cent, with the result that a spinner can handle a greater number of spindles.

A new garnet machine features a general adoption of ball bearings and chain drives for workers and other rolls. Individual adjustment of each worker and improved wire are other features. One manufacturer has brought out a combination wool garnet card which eliminates the separate garnetting operation. This machine is particularly adapted for hard ends of various types and will produce high-grade roping entirely from waste.

The cone system of twisting has been extended to worsted and woolen yarns with encouraging results. The winding of cones has been improved by new high-speed cone winders with a gear motion in the head which gives positive operation and maintains speeds.

Variable-speed spinning is being experimented with on worsted yarns, and it is reported that one worsted mill has so equipped all its spinning frames, using variable-speed d.c. motors to accomplish the required motion.

Perhaps the outstanding innovation in weaving machinery is the automatic pick-and-pick loom. This loom permits the shifting of the shuttle at either end of its travel so that a single lay of filling may be made, whereas its predecessor could not lay less than two. Thus is made possible the weaving of certain fabrics which were impossible on the previous automatic loom. To accomplish this result has necessitated a radical change in the bobbin-changing mechanism and magazine.

Minor improvements in loom operation are the introduction of a drop wire which spreads the warp when it falls so as to indicate the falling end, and a crepe-rubber covering to replace the sandpaper on take-up rolls.

For better preparation of warps there is a new hot-air cylinder slasher adapted to wide warps. This eliminates matched-beam work since it makes possible the running of an entire warp on one beam.

One of the interesting developments in weaving is the progress in making so-called American-Oriental rugs which now supply a large part of the domestic demand for "Orientals." By the employment of a modified Axminister weaving the pattern can be brought through to the back as in true Oriental production.

While on the subject of carpets, one of the outstanding textile-engineering achievements has been the production of a loom that will weave a carpet 20 ft. in width. This is truly a monster machine, weighing upward of 50 tons. It is driven by two motors placed at opposite ends and working in perfect synchronism. Electric control embodying solenoid brakes gives easy control, and automatically pressure-lubricated bearings give smooth operation.

For the finishing of wool fabrics, both the washer and the fulling mill have been increased in size and speed, making possible a greatly increased capacity and at the same time a better control of the processing. Slack-loop washers of this type have been finding a place for themselves for cotton and rayon goods during recent years, and have been greatly refined and improved to meet these more exacting requirements. One manufacturer has brought out a washer with a self-contained one-reduction motor drive. Another manufacturer features devices for throwing an unbroken sheet of water on the goods, and a non-leaking suds box so arranged as to carry the soap back into the tub while allowing the dirty water to escape.

There is a marked tendency toward a more general use of the mantel steamer, or so-called "semi-decating" machine, the general principle of which is a perforated cylinder on which the wool fabric is wound under a tightly drawn cotton cloth of fine texture and then subjected, in succession, to steam and vacuum. This is not a new machine, but it has recently been improved in its mechanical features.

Several new vacuum extractors have been brought out during the past year, and though no new principles are involved, there has been some tendency for this machine, which has been formerly applied only to woolen fabrics, to be used in connection with celanese and rayon.

Multiple-blade shears which were introduced in a small way a year ago are now obtainable in wide ranges and combinations. These permit in a single pass a specified number of shearings on both the face and the back of the cloth. In the case of carpets, shears have been developed up to 20 ft. in width, and have recently been equipped with air-driven selvage trimmers.

Tentering driers for woolens have been built of even greater capacity than in previous years. This is the result of more effective steam heating and improved air circulation combined with better-insulated housings. Cloth is now being delivered from the drier in a more uniform condition as the result of controlled speeds, temperatures, and humidities.

COTTON MACHINERY

Manufacturers of cotton machinery have more completely equipped their shops with precision tools and better equipment, so that they are producing better textile machines than ever before. In general their product is designed and built heavier, much more accurately, for easier and more efficient operation, for closer adjustments and settings, higher speeds, and for turning out an improved quality of product at minimum cost.

One of the principal advances of the year is the continued gain in popularity of the one-process picking. This machine or combination of machines is improving product, saving labor, and relieving floor space. The process involves a system of syn-

chronized control which makes picking and cleaning entirely automatic. A minimum amount of labor is needed, and the machines produce evener and better laps than is possible with two- or three-process work.

As a result of some investigation by the British Cotton Industry Research Association which indicated that the number of working flats on a card could be considerably reduced without impairing the operation of the card, one manufacturer has developed a new cotton card with only 48 flats in place of the 106 ordinarily employed. This machine also embodies another radical change, in that the position of the licker-in is well above the main-cylinder horizontal center line. This reduces the width of the back sheet, permitting it to be adjusted readily and accurately in relation to the cylinder wire.

Present-day machinery is permitting the spinning of finer yarns than ever before. One American manufacturer has announced that he was going to specialize on counts from 140s to 200s. Formerly yarns as fine as this have been supplied from England.

There seems to be an increased trend toward combed yarns, and to meet this trend the manufacturers of combers have brought out new models incorporating various important improvements such as the flexible top comb and the auxiliary nipper knife. This increased demand for combers is probably the result of the advent of rayon, which has caused a general demand for the cotton spinner to provide a cleaner and more even yarn.

We have already mentioned the pick-and-pick loom under woolen machinery, and have mentioned the improvement in warping machinery. In connection with weaving it might be well to mention a new type of portable warp-tying machine which has been developed this year. This machine is for use in narrow loom alleys and is arranged with a swinging bed which may be swung in toward the loom for tying in, and after tying is completed, brought back to a narrow base.

RAYON AND SILK MACHINERY

Tremendous progress has been made in the field of rayon, both in the manufacture of the synthetic fiber itself and in the development of the fabric. The making of the fiber is considered more in the realm of chemical engineering and is not further treated in this report. From the textile point of view, however, the uses to which this fiber has been put during the past year show marked progress. Fabrics formerly considered as standard silk constructions have been imitated most successfully. The production of finer yarns with differing degrees of luster and the development of yarns with varying degrees of twist have made this possible. Furthermore the use of cross-dyeing has brought added possibilities such as, for example, a worsted fabric containing in combination satin stripes of acetate silk, regenerated cellulose, and real silk. Rayon has at last been produced in which the individual filaments of the yarn are actually finer than the individual filaments of real silk.

Probably the most important trend during the year in silk and rayon machinery has been the result of the recent demand for high-twist, low-luster yarns, such as crepe and grenadine yarns. This has produced a number of twisters of improved design. The tendency is toward double-deck machines, and the machines are designed to produce tram, organzine, crepe, and grenadine as required, with twists varying from one to eighty turns per inch. In these double-deck machines each deck can be controlled independently of the other.

Winding machinery has been improved as well. One machine has been recently developed that winds bobbins or cops direct from skeins without previous intermediate winding. Another winder has been brought out for winding rayon on cones for the knitting trade or on tubes for warping and weaving, with special precautions in order to prevent sudden changes of tension.

A high-speed rayon warper has been developed which applies to rayon the principles of high-speed cotton warping. This machine has a speed of 150 yd. per min. The yarns are pulled from cones with over-end delivery, thus avoiding abrasion or straining of the individual yarns.

For the sizing of rayon warps a rayon slasher is now available, equipped with automatic temperature control and a three-roll quetch arranged for easy adjustment of pressure for all weights of rayon. A cooling cylinder follows the usual driers so that the rayon is not beamed hot. This cylinder is perforated and arranged so that a high-speed spiral fan within the cylinder forces a current of air out through the perforations, thus cooling the cylinder and the rayon that is in contact with it.

Several looms have been brought out designed especially for rayon, though cotton looms are still being adapted for rayon by the use of various appliances. Some of the improvements on looms for rayon are: take-up drums covered with rubber so as to eliminate injuries to the fiber; a let-off recorder for detecting irregularities in warp tension; an improved steel heddle so designed that it cannot cause abrasions of the filaments during shedding; and bakelite shuttles.

KNITTING MACHINERY

A development which has found more ready acceptance during the past year among the knitters is the yarn-conditioning room. This is a metal-paneled room equipped with a unit air conditioner in which yarn on the cones can be placed under controlled conditions of temperature and humidity until a uniform regain is established.

The tendency is still toward developing machines that will do finer work. We now have knitting machines with 36 needles to the linear inch. Among other developments is a fully automatic jacquard flat-knitting machine.

Variable-speed motor drives have been applied to full-fashioned machines with decided advantage by bringing about easy starting of the machine in any position, uniformity in the product under unusual conditions, and changing the machine speed at will.

In general, the improvements in knitting machinery are toward the production of finer goods, and toward new pattern possibilities and the employment of added automatic features.

BLEACHING, DYEING, PRINTING, AND FINISHING

A few years ago silk finishing and cotton finishing had little in common. In recent years, however, rayon, which is neither silk nor cotton, has come in, and by occupying a middle position between silk and cotton has brought them more together. The manufacturer of cotton-finishing machinery has had to refine his designs to a considerable degree, and the manufacturer of silk-finishing machinery has endeavored to make machinery of increased capacity. It has been found advisable to finish rayon fabrics at cotton speeds but with silk quality.

A new fuel for singeing has come into use during the past year in certain plants where city gas is not available, namely, compressed condensates of natural gas. One manufacturer has brought out a rotary plate singer that is internally fired with an oil burner, thus materially reducing the cost of operation of this same singer as formerly fired by gas.

A new development in kier boiling is the so-called pump and percolator kier. This kier employs a closed heater located inside the shell of the kier itself, thus obtaining the advantages of the closed heater and natural circulation without the disadvantages of injector heating and maintenance of pumps.

During the year just passed a continuous kier has been offered to the industry, though the machine has been in development and in limited use for several months prior to this year. In it cloth

is treated continuously either in the open width or in the rope. Each yard of the goods gets a uniform treatment, and thus the goods may pass comparatively rapidly through the process, several hours being saved over the prevailing method of kier boiling.

The year 1930 has also seen peroxide bleaching firmly established in numerous plants. Bleaching by this method is said to do in three operations what has required thirteen, and to do in eight hours what has required twenty-four.

Improvements have been made in rope washers both of the slack-loop and of the tight-strand type. A slack-loop washer has been developed for bleach-house use which combines some of the long-established processes of the woolen and worsted industry with some of the better practices of the modern bleach house, resulting in a machine which can be run at bleach-house speeds. This machine employs the suds box, which catches the dirty water squeezed out of the nip and so assists in securing very rapid and thorough cleaning. It also has a level control drain, and the countercurrent-flow principle, and is fitted to take a wringer mounted on the washer frame, so that a separately installed squeezer is not required.

The tight-strand washer has also been improved. Not until this last year has a practical countercurrent-flow tub been developed. This washer will scour more effectively than previous machines, and is in actual operation, using 33 per cent less water than is generally considered necessary.

For washing, boiling off, and otherwise treating rayons and silks a two-reel countercurrent slack-loop tub has been developed. This machine employs fourteen separate compartments in a single tub and lends itself to various operations such as boiling off and washing, tin washing-phosphating and washing, and soaping and chroming after printing, etc. It assures most gentle handling of the goods, and gives much greater effectiveness and efficiency in the use of water and steam than have previous methods.

Improvements have been made in dyeing machinery, particularly for handling rayon. A skein-dyeing machine of the circulating type especially designed to insure proper penetration has been brought out. For hosiery there have been developed a number of new rotary dyeing machines. Monel metal is generally used throughout.

As previously mentioned, the familiar vacuum extractor, formerly used exclusively on woolens and worsteds, has been redesigned by several manufacturers for use on rayon and celanese. A reel-dyeing machine has appeared of all-metal construction, which is equipped with an automatic stop for tangles and a pin rail made adjustable to permit handling of goods of differing weights.

An all-electric jig has been developed which has a motor on each beam roll. This permits one motor to act as an electrodynamic brake while the other motor is driving, and assures smooth, even, and controlled tension.

In the printing field, a loop-type drier for printed goods has been placed in regular service so that materials from either a surface-printing machine or one using engraved rolls may be dried in a heated atmosphere without contact with heated surfaces and without making any contact between the printed surface and any solid surface during the entire drying operation, at the same time keeping the size of the drier within the limits usually allotted to print-machine cans, and carrying on the drying operation in a tightly insulated housing.

A great deal of attention is being paid to the print-machine ager in an effort to secure maximum color value in the development of the dyes. In this connection various devices are being tried for obtaining and maintaining the optimum condition in the ager as to temperature and moisture. A device has been perfected for use on the continuous steamer for automatically returning the looping bars, thus dispensing with labor as formerly employed for this purpose.

A demand for preshrunk shirtings has brought about numerous methods and machines for producing a fully shrunk finish. In fact, this is probably the outstanding finishing development of the year. The most prominent of these methods is one which combines a special pin tenter with a feeding-in mechanism which feeds cloth into the machine at a predetermined rate in excess of the delivery rate, and as the cloth is stretched crosswise by the pin tenter the slackness in the cloth is transformed into a crinkle in the individual warp threads. Thus the cloth is delivered free from wrinkles, but with its warp thoroughly contracted or shrunk. A further machine in range with this frame, and operating in a somewhat similar manner, accomplishes the shrinking of the filling. Thus this combined range will deliver goods that are preshrunk in both filling and warp, and furthermore the amount of such shrinkage is under complete control.

Some of the other miscellaneous developments of the year are: an electric cloth guider, a print-machine copper-roll engraving machine that employs the jacquard principle, progress in photoengraving of textile patterns, pressure straining and centrifugal clarification of color pastes, and the use of chromium plating for engraved Schreiner calender rolls.

RESEARCH

In the field of research, progress is being made at accelerating rates. Improved methods of microscopy are now in daily use and are serving the textile industry in all stages from raw fiber to finished fabric. A new testing machine is now available for determining the comparative wearing qualities of various fabrics. One of the most ingenious and technical developments of recent months is an application of the photoelectric eye, by means of which device it is now possible to telegraph color measurements from place to place, or, in other words, to match shades by wire.

During the year just past, two major agencies have been created for the purpose of furthering research in our industry. One of these is the United States Institute for Textile Research, which was organized in May at a meeting of representatives of the various divisions of the industry. The Textile Research Council and the American Association of Textile Chemists and Colorists have merged their interests in the new institute. The other agency is the Textile Foundation, created by the Merritt Bill to administer, in textile research, the major portion of the $1,800,000 fund derived by the Textile Alliance from the sale of German reparation dyes. President Hoover has appointed three outstanding men in the textile field, together with the Secretaries of Commerce and Agriculture, to be the directors of this foundation.

CONCLUSION

The data on which this report has been based have been supplied by the various members of the Executive Committee of the Textile Division, and by numerous other associates and friends in the industry. In many cases these contributions have been incorporated into the report verbatim, and we hereby acknowledge our indebtedness to all who have furnished us data for this summary. Obviously, the field is too great to be covered adequately by such a report as this, and we have included only some of the more important developments. These few items, however, we believe, will indicate the trend in the mechanical side of the industry and will suffice to show that even with the industry in a most depressed condition, its engineers and technical men are still able to report progress.

PAUL A. MERRIAM.

Progress in the Iron and Steel Industry in 1930

Contributed by the Iron and Steel Division[1]

Executive Committee: W. W. Macon, *Chairman*, C. Snelling Robinson, W. Trinks, A. G. McKee, A. J. Boynton, G. T. Snyder, and F. C. Biggert, Jr.

WHEN the preparation of the present report was begun, it seemed for a while that a survey of technical progress in the steel industry in 1930 would have to take the form of the noted chapter on snakes in Iceland. Most people in the industry have been marking time, waiting for business to recover. Ingot production dropped approximately 25 per cent as compared with 1929 in the first 10 months; pig-iron production decreased about 23 per cent, and steel prices may roughly be said to have dropped 10 per cent as compared with 1929. The number of orders did not diminish appreciably, but the tonnage per order was very much decreased. As usual in dull times, the attention of management has been concentrated on improving efficiencies and effecting economies, which together with the natural reluctance to try out new methods or equipment requiring any great expenditure, has considerably retarded development as compared with the preceding year.

Nevertheless, on closer consideration, we find that considerable progress has been effected in spite of these adverse influences. Little that is startlingly new can be recorded, but there has been noticeable improvement and expansion of use, chiefly along the lines of tendencies which were clearly discernible last year or before.

Outstanding in its contrast to the general depression of the industry as a whole, is the extraordinary activity in the large-pipe or -tube branch of the industry. The demand for pipe and seamless tubing of large diameter at this time has been caused by the development of the gasoline and natural-gas business, and particularly by the projected transmission of natural gas over very long distances by numerous large pipe lines radiating in several directions from the southwestern gas fields. To supply this demand, two firms have put in operation seamless-tube mills for making tubes up to 24 in. in diameter, of about $^5/_{16}$ in. wall thickness, and about 40 ft. in length. These seamless tubes have to meet stringent specifications for almost perfect surfaces both inside and out, for straightness, and for almost micrometric accuracy. Needless to say, the troubles encountered in this new development in piercing, expanding, and manipulating such large tubes have not yet been completely ironed out. One of these firms has also built a new plant for making electrically welded steel tubes, which, although not entirely completed, is producing several miles of pipe per day; and the other has for some time been producing as much as 10 miles of 16-in. pipe per 24 hours by the electrical pressure-welding process. Still another firm has produced several thousand miles of electric arc-welded pipe, and during the year made the first 26-in. gas pipe. Methods of joining the pipe sections by welding in the field have been further developed. At another plant, changes are being made in the pilger mill which will increase capacity and improve surfaces.

One bright feature of the situation is the opening of research departments in a number of steel plants, although the amount of research actually carried on has been curtailed by the usual tendency of the steel industry in dull times to reduce expenditures for everything not considered directly productive.

Blast Furnaces

During the year, at least two furnaces were constructed or rebuilt which each have a capacity of 1000 tons per day.

The charging equipment for furnaces which have been rebuilt for larger production, has been taxed to or beyond its capacity by the enormous weight of the material to be handled. At one plant an installation of Ward Leonard control for electrically operated hoists has given good results.

The efficiency of stoves has been considerably improved by reducing the size of checker openings, using thinner checker walls, and improving the heat insulation, especially over domes and at hot sections; and by the use of thoroughly cleaned gas. There has been a very decided trend toward thorough cleaning of blast-furnace gas used for heating the stoves.

The size of ladles has been increased, 20-ton ladles often being replaced by others of capacities up to 70 tons.

The use of instruments, such as stock-line recorders, CO_2 recorders for the top gases, etc., has grown. There has been continued improvement in the technique of blast-furnace operation. Valuable research is in progress on blast-furnace slags.

Open-Hearth Furnaces

In districts with high fuel costs the necessity for economy in the use of outside-purchased fuel has given an impetus to the use of mixed gas in the open hearth—that is, a mixture of blast-furnace gas and coke-oven gas. (The problem of producing a luminous or highly radiant flame with mixed gas, without the use of tar, was solved two years ago.) It seems to have been definitely shown, however, that for best economy a penetrating, high-temperature, not necessarily luminous flame is required for melting down scrap; while a slower, highly luminous flame is best during the refining period.

A large steel company in the Pittsburgh district has utilized abandoned natural-gas wells for the storage of excess coke-oven gas, thereby obtaining almost unlimited storage capacity and eliminating both the danger and the expense of huge above-ground tanks.

An important development is the movable port, which is automatically placed or removed at each reverse. By this means the gas velocity can be as high as desired, but the outlet area is not obstructed since the gas port is withdrawn from the outgoing end. This permits the relative proportion of burned gases going to the air and the gas checkers to be regulated as desired by means of slide dampers in the flues, and without excessive draft on the checker chambers.

Research, in which the Bureau of Mines played an important part, has led to new methods of analysis—for instance, in determining the amount of FeO in steel—and to new methods of killing steel yet eliminating the oxides formed in doing so. As yet, however, there is no reliable method of determining, for control

[1] Compiled by J. D. Keller from material furnished by Messrs. F. C. Biggert, Jr., A. C. Dinkey, W. N. Flanagan, C. H. Herty, Jr., John C. Long, Arthur G. McKee, Richard Moldenke, H. S. Rawdon, L. F. Reinartz, W. C. Ross, W. B. Skinkle, George T. Snyder, and F. N. Speller.

purposes, the oxygen in the steel bath before tapping. Much study has resulted in better understanding of the interaction between slag and steel, and of the action of metal on furnace bottoms.

Tests made in Germany have shown that the wear of the roof and side walls of open-hearth furnaces is practically independent of the wall thickness, because it is caused by a chemical action rather than by a thermophysical action.

The serious application of automatic control to open-hearth furnaces has just begun, although a few furnaces were partially equipped some years ago. Such control is limited to stationary (non-tilting) furnaces. There are at least 10 furnaces in this country now under such control, but it is too early to be able to make any definite statement as to results. Most of the operators seem to find the air-and-fuel-metering feature of greater importance than the automaticity. Furthermore, since a fan must be used to produce the pressure difference required for metering, the reserve air-supplying capacity thereby afforded is a gratuitous advantage which may prove more important than the primary function of metering.

The use of metering devices and of automatic control has made the prevention of leakage into and out of the checkers, not many years ago scoffed at as "utterly impracticable," an absolute necessity. In existing installations, the removable parts of the checker-chamber wall, or the "blinds," are covered with insulating material in the form of large slabs, with few joints; and the entire outer surface of the chambers is painted with a mixture of insulating powder and molasses. In new installations being erected the checker chambers are being completely enclosed in steel plate. The slag pockets, uptakes, and ports are sprayed or "shot" at regular intervals with a mixture of silica, fireclay, and water by means of a cement gun.

The subjects of oxygen in steel and general cleanliness of steel have been given increased attention. One plant has resumed an old practice of pouring through a metal tube set in the mold to reduce splash.

Jarring machines for ingot molds have been perfected during the past year. These machines, by keeping the metal in continual slight agitation while it is solidifying in the mold during teeming, not only reduce the size of the gas bubbles which form in a layer at a distance of $1^1/_2$ to 2 in. from the outer surface of the ingot, but allow much more of the gas to escape. The jarring machines are claimed to permit the use of effervescent steel for higher carbon contents than heretofore.

Experimentation to determine the best shapes, contours, lengths, and thicknesses of ingot molds has been continued, but has by no means led to any fixed practice. The use of hot-topping practice and big-end-up molds has created a demand for equipment to clean hot-top refractory material from the ingots, and for suitable stripping and handling equipment.

Rolling Mills

Electrification of mills has continued to make progress. A large electrically driven reversing blooming mill, installed during the year, of 54 in. diameter, 10,000 hp., has separate motors for the top and bottom rolls, thus eliminating pinions; the synchronism between the rolls is maintained electrically. In some mills vertical-shaft motors have been used for driving the edging rolls, obviating the use of bevel gears.

There has been considerable extension of the process of continuous wide-strip rolling, replacing sheet rolling by the hand process. The lower limit of thickness to which the strips can be hot rolled by this process has been further reduced by covering the strips with soda ash, doubling, and rerolling continuously. In this way the thickness can be reduced to 24 gage (0.025 in.).

For still further reduction, the strips are cold rolled under tension by rolls of small diameter at speeds up to 800 ft. per min., with 85 per cent reduction in 4 passes (50 per cent in the first pass). The rolls are bathed in water, which acts not only as a coolant but also as a lubricant. In spite of this, the wear of the rolls is very rapid and their life is short; but efforts are being continued to obtain roll materials of improved wear-resisting qualities.

A few mills are ready to tin or galvanize these long strips and furnish the coated material in this form. All that is holding back immediate utilization of this development is the cost of changes in plants of makers and users of tin plate, especially can makers.

With the extension of continuous strip rolling has necessarily come increased use of anti-friction bearings, but the latter have also been increasingly applied to other forms of mills, and in fact to general steel-plant use. The research on rolling pressures, carried on under the auspices of the Committee on Heavy-Duty Anti-Friction Bearings, has led to greater confidence in the use of these bearings.

The demand for greater accuracy and closer tolerances, particularly in bars, has led to the use of pyrometers which measure the temperatures at all points in the length of the bar while it is being rolled. By this means the heater is guided in adjusting the burners in the heating furnaces, in such a manner as to insure constant temperature of the bar as it enters the finishing pass.

The more exacting demands for nearly perfect surfaces, for instance, in strips and tubes which are to be chromium plated, has necessitated a great increase in pickling and chipping; the rounds for some kinds of seamless tubes are now being pickled before piercing. Special machines have been installed by a leading producer of seamless tubes for taking a peeling cut from the entire outer surface of rounds for the seamless mill, in order to remove small surface defects and expose the steel for further exploration and chipping. More rigid requirements for straightness have resulted in the rapid development of straightening machines, particularly for tubing and for structural shapes.

Small bars or band iron are now rolled at speeds up to 2000 ft. per min. in a continuous merchant mill.

Furnaces

There has been steady growth in the use of continuous furnaces in the sheet-steel industry, for slab, pack, and pair heating as well as for normalizing.

The rocker-bar type of furnace has been applied to heating automobile parts for forging (2200 deg. fahr.), and has been made successful for these high temperatures by the use of nickel hearths.

The use of electric furnaces for melting has grown. Older furnaces have been removed and new ones of larger capacity have been installed. The use of recuperative soaking pits continues to extend. Improvements in producer-gas burners have been effected, and some attempts have been made to use raw gas in small burners.

Developments in atmosphere control included a method of producing a non-scaling and non-carburizing gas (electrolene) by treatment of city gas, and a control arrangement whereby an excess of city gas is supplied as a curtain in front of the opening when the furnace door is opened.

Normalizing has been extended to other products besides sheets, and many furnaces have been installed for normalizing bars. A normalizing furnace of three zones for tube annealing is under construction, designed for 50 tons per hour capacity and for completely automatic control.

A charging machine capable of handling plates 60 ft. long was developed in England for plate-normalizing furnaces.

ALLOY STEELS—STRUCTURAL STEELS

The use of stainless steels and irons for architectural decorative purposes and for automobile trim has grown, well-known instances of its application being the top of the Chrysler Building and the Ford radiator shells. The stage has not yet been reached, however, where the actual load-carrying members of structures can be made of corrosion-proof steels; meanwhile increased attention has been given to reducing the corrosion of ordinary steels.

The United States Steel Corporation has reached a production basis on corrosion- and heat-resistant low-carbon steels.

The problem of buffing and polishing stainless-iron parts by automatic machinery seems to have been solved; this was the main obstacle to rapid extension of the use of the material in this country.

Stainless alloy steels of the manganese-copper-chromium type have been developed for work requiring the deep drawing of sheets, and two different types of free-machining stainless steels have been produced for use in parts requiring machining. These are said to be equal to screw stock in free-cutting qualities.

Centrifugal casting of steel billets has been operated during the past year on a commercial scale. The Ordnance Department of the Army has continued the development of the casting of guns by the centrifugal process, and has adopted it for the making of small-caliber guns for the Army. Rustless-steel pipe have also been made by the centrifugal-casting method.

There has been an increased use of alloy steel for forgings, both of stainless and of other alloys; and a further application of quenching and tempering of alloy-steel castings.

In England, Hadfields have developed a nickel-chromium-tungsten steel for gas-turbine rotors. In this country a nickel-molybdenum steel has been produced for great strength at high temperatures.

The use of alloy steel for bridges is again increasing, as instanced by the use of manganese steel in the Kill van Kull bridge. It has been stated that construction engineers are pushing the metallurgists too far in the endeavor to obtain a structural steel of high tensile strength without heat treatment. There has been some heat treatment of plain carbon steel as well as of alloy steel, and heat treatment of low-alloy structural steel as well as of welded joints has been developed at Mare Island Navy Yard.

There has been a steady growth in the use of welding in place of riveting of structures, over 100 buildings and bridges being now in existence in this country which have been constructed entirely by this method.

The use of the steel "battle-deck" type of floor for the construction continues to grow. A 15-story apartment building has been projected for Chicago, using welded-steel framing and steel battle-deck floors. Steel bases and curbs for highways are being tried out in Illinois.

FORGING, WELDING

Very large forgings have been in demand, and there has been increased use of hollow forgings.

In die forging, methods have been developed to prevent "running out" of the fibers, and to avoid detrimental rearrangement of the flow lines of the original bar.

Large pressure vessels have been electrically welded: as an example, towers 9 ft. in diameter, 60 ft high, with $2^{11}/_{16}$-in. walls. An alloy-steel drum 26 in. in diameter and 33 ft. long, electrically welded, was designed for 5000 lb. per sq. in. operating pressure and tested hydraulically to 10,000 lb. per sq. in. The great development of electrically welded pipe and methods of welding pipe sections in the field, and the heat treatment of welded joints, have already been mentioned. X-ray testing has been applied to welded joints.

WROUGHT IRON—CAST IRON

The new plant of the A. M. Byers Co. for the production of synthetic wrought iron by the Aston process was put in operation in October. It is located near Pittsburgh, and has a capacity of 45,000 to 50,000 tons per month.

The foundries have had a very dull year, and for that reason the extension of the use of recently developed cast irons of very high tensile strength has not been as rapid as was expected.

The use of electric furnaces for melting cast iron has gained somewhat.

A cast iron containing nickel, chromium, and copper, recently developed, is practically free from growth and scaling at high temperatures. It is more resistant to heat and to corrosion than ordinary cast iron, and has been employed for pipe fittings and other castings used in oil refineries.

SURFACE TREATMENT

A new method of carburizing by natural gas under pressure was brought out during the year. Surface hardening has been performed in England by the use of the oxyacetylene flame, with after-quenching.

The growth of nitriding has been extremely rapid. The process has been applied to very large pieces such as large forgings and rolls. Detail improvements included reduction of warpage, lowering of cost, and the development of a protective paste or cement for covering adjacent parts on which a nitrided surface is not desired.

Protective coatings and special treatments to reduce corrosion of steel have been extensively applied, particularly to pipe lines.

There has been some commercial application of the electrolytic process of depositing rubber coatings on steel; and additional use of arc welding for depositing stellite or other hard alloys on steel surfaces.

BILLET CHIPPING—MACHINING

Efforts to do away with hand labor in the chipping of ingots and billets have been continued. In a new design of planer-type machine, or "gouger," much greater flexibility of motion and control of the tool in all directions has been the aim of the manufacturer. The use of tungsten carbide has been increasing. It has been used in a high-speed circular saw for cutting billets.

TESTING

X-ray testing has received further industrial application. Welded joints, in particular, are tested in this manner, for instance, in gun carriages built up of structural shapes. Steel castings for pipe fittings to be subjected to 1350 lb. pressure have been X-ray tested. Further improvement has been effected in the penetrating power of the apparatus, adapting it to use with thicker sections of metal.

Magnetic testing of rails was continued on many railroads, with encouraging but apparently not yet conclusive results.

Improved methods of determining the FeO content of steel have resulted from research, and some specifications for steel now include a clause limiting the FeO content.

MISCELLANEOUS

An electrolytic pickling process was brought out, using lead cathodes, an acid tank, and an alkali tank. The process deposits a very thin coating of lead on the pickled surface.

Another process recently developed is intended to prevent the occurrence of black annealed stickers in the sheet-steel industry.

A method has been developed in Europe for raising the fatigue limit of steel by cold rolling or compressing the surface parts under stress after, or in place of, grinding.

Progress in the Wood Industries

Contributed by the Wood Industries Division

Executive Committee: Thomas D. Perry, *Chairman*, Chester L. Babcock, *Secretary*, James S. Mathewson, Armen S. Kurjian, and Ralph K. Merrill

MILEPOSTS of progress are not so easy to define or to limit as are milestones on the road, and intermediate stations can be less accurately located. Hence, The American Society of Mechanical Engineers' progress reports should occasionally deal more with comprehensive movements culminating as the years roll by, rather than with events transpiring wholly within the calendar years. We have had detailed reports for several years enumerating most interesting and resultful annual progress, but for the past year business volume has been at low ebb and the problems of survival have been much more pressing than those of undertaking new tasks. Specifically the current year could hardly be characterized as one of distinctive progress, and it therefore seems opportune to give more thought to the deeper currents of fundamental progress that are powerfully making themselves felt in the woodworking world of today.

The New Competition

A perspective view of several decades of woodworking development indicates that the trade has progressed slowly, and almost wholly by what might be termed internal evolutionary movements. Woodworkers of the executive groups have been almost entirely trade trained, and have had little if any encouragement and assistance from outside the limits of the industry. For many years this internal trade training was adequate and kept the woodworking industry relatively on an efficiency par with other industries of similar rank. Technically trained men, educated in specific industry courses, were singularly lacking, and are not as yet available.

Recently, however, many industrial groups, much younger than woodworking, have made tremendous forward progress and have introduced the new competition, not within an industry, but between the products of different industries. Once the family problem was whether to buy a walnut, or oak, or mahogany suite for the bed room or living room, but now it has become a choice between the radio, iceless refrigerator, washing machine, a new fur coat, or an exchange of automobiles. The less aggressive and ineffectively promoted products have suffered greatly, and it is not possible to include wood products in other than the losing group.

Research Imperative

The most progressive and enlightened woodworkers of broad vision and wide perspective have become convinced that their industry needs a drastic and somewhat ruthless overhauling, in order to restore it to its former importance and profitability. It is not difficult to discover that research is the fundamental reason why so many modern products have an appeal far more compelling than that of wood products, no matter how sturdily and artistically they may be made. Without research we should have no electric light, no radio, no automobile, in fact, very few of those modern products that make life worth living.

Research is of two kinds, fundamental and applied. The fundamental or pure research embraces the scrutinizing of scientific facts with regard to raw materials and their conversion, but seldom concerns itself with the gainful character or industrial application of these facts. Such is the logical function of our educational institutions, Government bureaus, and other public and semi-public laboratories, where scientific background, resourceful minds, logical procedure, and mental caliber of workers are more adapted to scientific discovery and disclosure than they are to gainful procedure.

The branch of applied research is that of converting the fundamental facts into profitable industrial application. Quite a different type of mind is required to sense and grasp the dollar value, to "sell" the idea to industrial leaders, and to explore and complete the intermediate steps that are necessary between the fundamental idea and its profitable application. There has been some confusion in American industrial life between these two branches of research and the border zone has been a bit vague, but the division is becoming increasingly clear.

We are beginning to realize that fundamental research should be undertaken at public expense, and that industry must definitely sponsor and father applied research. There are three principal reasons for this. In the first place, those who profit by the results of applied research should meet the cost of obtaining these results. Secondly, the "profit-minded" rather than scientific investigative type of individual is best able to convert elemental physical facts into realizable "coin of the realm." And last, fundamental-research facts are usually public knowledge, and applied-research facts ought to be kept inviolable for their owners.

Economic Position of Woodworking Industry

There is another fundamental cause, in addition to the inertia of the industry, that has prevented the woodworkers from undertaking research on an adequate scale. Research has been the basis of all progress in such industries as iron and steel, textiles, electric products—trades that seem complicated and intricate, and require extensive equipment and processing. On the other hand, woodworking has been regarded as a simple art or trade requiring little capital and moderate ability. Dr. Wilson Compton, secretary-manager of the National Lumber Manufacturers' Association, stated this (June, 1930) to the American Association for the Advancement of Science in terse and graphic form. While this statement is directed at the lumber industry, or the primary conversion of the log into lumber, it also embraces the remanufacturing operation that is included in the statistics.

> Of the 20 leading American industries [says Dr. Compton], not including agriculture or the railroads, the lumber industry ranks second in the number of persons employed, third in the extent of its investment, and eighth in the value of its products. But in the lumber industry the annual value of products is only 25 per cent of the aggregate value of its investments in timber and plants. In the automobile industry, at the other extreme, the annual value of products is 50 per cent greater than the aggregate capital invested in automobile manufacture. Of the 10 largest American industries, only one shows as low a ratio of annual product to aggregate investment as does the lumber industry. Herein lies one of the lumber industry's most difficult economic problems: A relatively high percentage of fixed assets; and, in relation to annual income, a high ratio of investment in tangible property subject to increasingly heavy

annual taxes, and seeking relief from multiplying capital carrying costs through quick liquidation. This is at the foundation of their present familiar, costly, and wasteful trend toward overproduction throughout the lumber industry.

WOOD WASTE

The waste of one generation must become the profitable by-product of the next generation. Again Dr. Compton has made a clear and convincing statement.

Of the annual drain upon the forests of the United States, less than 35 per cent goes into the manufacture of lumber. Nearly 40 per cent is used for fuel; only 4 per cent for pulp and wood chemical purposes; over 10 per cent for miscellaneous products, such as fencing, cooperage, poles, posts, and piling. Another 10 per cent is destroyed by forest fires, tree diseases, and forest insects.

Of the average tree cut for lumber manufacture, one-fourth, including defective trees, tops, limbs, and stumps, is left in the woods unutilized, because there is no present use for it. Of the log brought to the sawmill one-fourth, consisting largely of bark and the saw kerf, is not utilized except for fuel. Another fourth, consisting of slabs, edgings, and trimmings, is usually converted, so far as possible, into by-products, such as lath and miscellaneous small dimensions. The other 50 per cent of the log emerges in the form of rough lumber.

Nor does the loss of material end there. When the finished lumber itself is used, the further fabricating losses in building usually range between 5 and 15 per cent; in box manufacture, between 10 and 15 per cent; in car construction, about 10 per cent; in furniture making, nearly 25 per cent. Therefore, of the total wood content of the average tree as it stands in the woods, only 35 per cent in its finished form is finally used in ordinary building, and less than 30 per cent in the more exacting manufacture of finely fabricated wood products. These facts give a fair quantitative measure of the stupendous physical opportunities for more complete utilization of raw material in the wood industries. They provide a great field for scientific exploration.

INDUSTRIAL RESEARCH

Another, and a last glimpse into Dr. Compton's vigorous report reveals the value that other industries place on research.

The annual expenditures for laboratory research by American manufacturing industries are nearly 50 million dollars, and on industrial research of all kinds, nearly 100 million. The annual savings to these industries traceable directly to research are at least a half billion dollars. Positive advances in American industry, traceable directly or indirectly to scientific research, cannot be accurately computed. But since much of the striking industrial progress during the last third of a century is known to have had its start in the research laboratory, these gains probably run into billions of dollars annually.

Annual expenditures in forestry research, on the other hand, do not much exceed $3,000,000. Of this over a million and a half is by the United States Government. Probably one-quarter million or thereabouts is by the states, perhaps $100,000 in endowed institutions, and a little over a million dollars annually by the wood-using industries. . . .

If the lumber and wood-using industries are in the long run to hold their own, if forest lands are to be maintained in productivity, and if research is in fact the gateway to such achievement, the present aggregate research programs in forestry and forest products should within the next quarter-century be multiplied tenfold. Public agencies, state universities, endowed institutions, and forestry organizations will have to do most of the research in silviculture and in fundamental wood science. The wood industries themselves will do well if they will progressively occupy more of the field of investigation in the mechanical, physical, and chemical treatment and uses of forest products. Larger operating units in the lumber and wood-using industries, to be best accomplished by proprietary mergers, will add greatly to the facilities and the advantages of the industries themselves to do effective research on a broad scale in these directions.

WOODWORKERS REALIZE THEIR DILEMMA

This inexcusable inertia in undertaking a research program for wood products reflects no credit on the woodworking industry, and must be speedily overcome. The industry needs new products, better processes, and a wider publicity and promotional program. It has been demonstrated by the paper and pulp industry that many new products can be developed by trade research, and it is estimated that 40 per cent of its products were unknown ten years ago.

The most cheering fact in this somewhat embarrassing dilemma of the industry is that its leaders recognize the challenge and are courageously attacking the problem. Industrial mergers are setting up their research programs, and trade association meetings are echoing with research plans.

THOMAS D. PERRY, *Chairman.*

Electric Resistance Brazing

ELECTRIC brazing is a comparatively recent development. There are two methods, of which one depends for its heat upon the electric resistance of the metals being joined and requires comparatively high pressures. This process is usually referred to as pressure brazing. Another process utilizes the heat generated by passing current through a pair of carbon blocks having the joint clamped between them and is known as resistance brazing. This was developed by the General Electric Company, and is now being used in transformer manufacture as well as being offered commercially. This method provides a dependable, quick, sure joint. The blocks heat readily at a lower current rating because of their high resistance. Less pressure is required than in the previous method, and the heating is so rapid that the metals being joined are affected but slightly. The comparatively low temperature also prevents carbon breakdown or "grain growth." The joint is created by applying a thin strip of brazing alloy at the contact surface, the alloy flowing through the joint section and combining with a thin section of the joined metals to make a solid mass. Three different silver alloys are now being used as brazing media, depending upon the type of joint being made. One contains 50 per cent silver and has a melting point of 725 deg. cent. (1337 deg. fahr.), another contains 30 per cent silver and melts at 735 deg. cent. (1355 deg. fahr.), and the third contains 10 per cent silver and melts at 830 deg. cent. (1526 deg. fahr.). In order to protect the insulation and prevent overheating small copper wire, the brazing must be kept at an absolute minimum of temperature, necessitating the use of the 50 per cent alloy. On larger cables, conductors, and terminals the 30 per cent alloy is used because of its decreased cost. The alloy containing 10 per cent silver is best suited for brazing heavy bus bars, plates, and the like.

Fused borax is generally used as a flux, but in some cases potassium acid fluoride is used in paste form. The surfaces of the metals to be brazed should be flat at the joint to insure good contact with carbon blocks and prevent arcing and hot spots. Stranded cable can be joined by brazing. It is not essential to clean the surfaces for brazing to the same extent that is done in soft soldering, since the brazing flux removes the oxides and most other impurities. Certain alloys and varnishes, however, are not removed by the flux and should be removed before brazing. The advantages of this process are claimed to be saving in time in making the joint as compared with lead soldering, greater strength, better electrical conductivity, and comparative cheapness due to the small quantity of alloy used.—W. C. Reed, in *American Machinist*, vol. 73, no. 20, Nov. 13, 1930, pp. 779-781, 4 figs.

Survey of Engineering Progress

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS (See also Engineering Materials: Corrosion of Light and Extra Light Metals and Alloys)

A Hollow Steel Propeller

THE Pittsburgh Screw and Bolt Corporation, Pittsburgh, has now in commercial production under the Dicks patents a hollow steel-blade propeller, while the Hamilton Standard Company, also of Pittsburgh, is developing another similar propeller. The original design of the Dicks propeller was described in MECHANICAL ENGINEERING, Vol. 44, No. 9, Sept., 1922, p. 577.

In the Hamilton propeller a tube is employed, while in the Dicks propeller two steel plates are welded together. In the latter, chrome-vanadium steel S.A.E.-6130 is used, the two faces of the blade being cut of correct thickness and shaped to the proper contour and angles in special dies.

Welding of the two plates is a special feature of the blade's construction, the process involving a joint that prevents the seams from becoming either the leading or trailing edge of the blade. This is accomplished by cupping one plate sufficiently to permit the other to set within it, thereby eliminating tension in the weld. The blade root is formed from the inner ends of one of the steel sections.

Weight of steel has been one of its disadvantages in the past in use for airplane propellers, but the new type of hub design employed eliminates considerable weight without the loss of strength, compared with the standard type of hub now in use.

The ultimate tensile strength and fatigue limit of the chrome-vanadium propeller steel are respectively 100,000 and 50,000 lb. per sq. in., as compared with 55,000 and 12,500 lb. per sq. in. for the age-hardened aluminum-alloy blades.

An interesting development in connection with the hollow steel propeller of the Pittsburgh Screw and Bolt Corp. is the provision for the escape of motor exhaust gases. This is accomplished by leading the gases into a collector ring and then to the hollow propeller blade, from which they leave through small slots cut into the trailing edge of the blade.

In the Hamilton propeller the cold-drawn tube is swaged to the required shape and length. After upsetting a flange at the hub end, the tube is annealed and then expanded to the proper contour. (W. J. Gude in *Steel*, vol. 87, no. 22, Nov. 27, 1930, p. 56, 1 fig., *d*)

Flying the Autogyro

THE claim is made that any airplane pilot can fly the autogyro safely after a few minutes of verbal instruction on the ground, as practically the only instruction required for accredited pilots is that concerning handling the controls for the mechanical rotor starter.

The author, who for a long time has been an instructor in flying, claims that there are two things on which instructors spend about 90 per cent of the dual period—one being avoidance of slipping into a spin from loss of flying speed, and the other, landing practice. Even after the student has spent considerable time in dual instruction, he must practice for hours in the air before he can make a turn which could be called safe if executed near the ground, with or without his motor. The same applies to landing. In an autogyro all this training in avoiding spins and making possible landings is unnecessary. The machine is inherently stable. An autogyro cannot spin, and it practically lands itself from any altitude.

The pilot who flies an autogyro for the first time is confronted with one difficulty which is largely mental. All his instinct revolts against such things as the vertical descent, and yet it is a perfectly natural attitude for the autogyro and an accepted manner of losing altitude and of landing. It is only reasonable to suppose that a man accustomed to flying small, fast ships of the pursuit type might find the large autogyro sluggish on the controls—but this again is purely mental.

The article states that seven pilots of the Department of Commerce in Washington have soloed the autogyro, bringing the machine in for vertical landings on the first solo hop.

From a specification appended to the article it appears that the high speed of the autogyro is 120 m.p.h.; cruising speed, 100 m.p.h.; and minimum flying speed, 20 m.p.h. Take-off run, 30 yd.; take-off speed, 25 m.p.h.; landing run and landing speed, 0. The above performance is for a plane powered with a Wright-240 motor and carrying a pay load of 600 lb. (James G. Ray, Vice-President of Pitcairn Aviation, Inc., in *Airway Age*, vol. 11, no. 11, Nov., 1930, pp. 1427–1429, 3 fig., *d*)

Rotary "Thumbs"

WHAT are known as "rider" planes and "alulas," i.e., planes used immediately in front of the main plane for the purpose of controlling the flow of air adjacent to the surface of an airfoil, are devices well recognized in aeronautics. Recent tests have shown that the lift of the main plane at a given angle can be increased by increasing the width of the gap between the "rider" and the main plane, whatever the inclination of the "rider" plane may be between —10 deg. and +10 deg. It was also found that this increase is primarily due to change of pressure on the suction side of the main plane. Alteration of the angle of the rider plane appears to alter the lift of the main plane in a similar way to that obtained by variation of the main plane alone.

The author showed in September, 1928, that the "thumb" of a bird's wing is used by the bird to hold the air on to the top surface of the wing when it is at a large angle to the air, thereby preventing "depression" and "stalling." He noticed that when pigeons take off from the ground they sometimes make a rapid angular stroke with their "thumbs," approximately in the plane of the wing—that is, the "thumb" shoots out rapidly to a considerable angle with the front edge of the wing. In order to investigate whether the motion of the "thumb" had any effect apart from its position, a small plane or "rider," set at a negative angle to the main plane, was mounted so as to be capable of turning about an axis transverse to the main plane.

It was found that this small plane seated itself tightly against the top surface of the main plane when the angle of incidence of the main plane was small, and lifted away from the surface and rotated at high speed when the angle was large. Under

the latter condition it gave a large lift and delayed "stalling."

If, then, this movement of a "rider" in relation to the plane can be rendered continuous at an excessive, or what is normally a "stalling," angle for the plane, "stalling" can be prevented and the lift of the plane maintained. A convenient construction is that in which the "rider" is given a two-bladed helical formation by shaping its opposite blades to "nest" upon different zones of the upper surface of the nose parallel with the leading edge of the plane, and to mount it upon the plane, at a point intermediate between its ends, so as to turn about an axis inclined forwardly from the perpendicular to the chord of the plane.

Experimental investigations in a wind tunnel show that the "stalling" angle of the main plane can be increased with one disposition to an angle of about 34 deg., and that the total lift can be considerably increased.

The area of the rotor plane of these experiments was about 1/30th of that of the main plane but it increased the total lift about 30 per cent. (A. P. Thurston, D.Sc., in *The Aeroplane*, vol. 39, no. 13, Sept. 24, 1930, pp. 718, 720, and 722, 5 figs., *de*. Compare with paper by the same author on a "New Method of Controlling the Flow of Air Adjacent to the Surface of an Aerofoil," in Proceedings of the 5th International Congress of Aerial Navigation, The Hague, 1930.)

The M.A.T.A. Airport—Income of Airports

THE Massachusetts Air Terminal and Arena will be located at Norwood, Mass. on a plot of ground comprising 1298 acres. It will serve the Boston-Metropolitan area. In connection with this project a booklet has been prepared by the company promoting it, in which are given certain figures of actual and prospective income of and rates charged by the M.A.T.A. and certain existing airports. The figures given below are as reported in the booklet above referred to. No effort to check up their correctness has been made.

AN AIRPORT'S INCOME

The income of an airport is from rentals of landing, parking, and garage (hangar) space to plane users; the rental of hangars, showroom space, store rooms, office and landing space to those who sell planes, rent them, or teach their use; from the sale of gasoline, oil, parts, repair, inspection, and general "roundhouse" service; and from the accommodation of the large number of people who are occupied in these services and those who come to fly or watch flying activities.

Airplanes must stop, park, garage, refuel, and be inspected, serviced, and repaired all at one place, and such places will always be comparatively limited in number. Automobiles can stop at the curb, be garaged in the back yard, and secure gas at every corner. In spite of this the concentration of automobile garage, service, and sales space has produced a great industry. With the airplane this concentration must be absolute and include parking, fuel, and garage.

Sales organizations, managers of commercial flying, pilots, mechanics, repair, inspection, and fuel men must have offices, work space, and store rooms. The public which comes to fly, the automobile and drivers which bring them, and the many who come to see them arrive and depart or to watch flying generally, must be accommodated.

Receipts from food, fountain, amusement, parking, and other minor concessions at one successful port form 30 per cent of the total income.

Percentages on sales of oil, gasoline, and mechanics' service, generally called major concessions, average about 35 per cent. Ground and hangar rentals for planes are the largest single source.

EXAMPLES OF INCOME

Airplane storage, according to size.....$35 to $75 monthly
Public aircraft repair shop (Oakland, Cal.) lease...$5300 annually
Use of small floodlights, $2; large floodlights.....$3 an hour
Commercial operation fees—use of port, per plane, $45 to $90 monthly
Office and store rentals (Fairfax Field, Kansas City, Kan.)
.....$26,000 yearly
Airplane manufacturers (Buffalo).....$0.58 per sq. ft. per yr.
Mechanics' time (Grand Island, Neb.).....$1.50 per hour
Lunch-room concession (Mills Field, San Francisco)....$50 a month
Rental (Oakland) locker, $1; tool box, $1; bunk....$15 per month
Occasional take-off or landing (Pontiac).....$1
Gross sight-seeing flight income (Portland, Maine).....25 per cent
Commissions or profit on sale of gasoline, oil and supplies.

Tulsa, Okla., Airport Statement, Six Months Ending Oct. 1, 1929:

	Income	Expense	Net Profit
Gasoline and oils.....	$53,347.32	$40,549.25	$16,798.07
Service and parts.....	866.02	489.69	376.33
Pilots' hotel.....	1,339.65	475.00	864.65
Concessions.....	445.05	25.00	420.05
Storage and operations.	7,762.00	2,459.98	5,302.02
	$67,760.04	$43,998.92	$23,761.12

Annual air circus or pageant (Schenectady) net profit.....$1000
Night or day plane parking (St. Joseph; St. Paul, et al.).....$1
Moline, Ill., and Portland, Oregon, $2 a night
Seats in grand stand or stadium, rental athletic field (see Dept. of Commerce Aeronautics Bulletin No. 17)
Land lease for hangar sites (Atlanta Municipal).....$100 a year

(Pamphlet published by M.A.T.A., Inc., *g*)

CORROSION (See Engineering Materials: Corrosion of Light and Extra Light Metals and Alloys)

ENGINEERING MATERIALS (See also Metallurgy: Influence of the Chemical Composition of Melt on the Physical Properties of Malleable Cast Iron)

Materials for High-Pressure Installations

THE article here abstracted reports the contents of three papers—one by Dickenson in 1922 before the Iron and Steel Institute, another by John Anderson before the Institute of Fuels in November, 1927, and a third one which is a symposium presented at the general meeting of the German Association of Boiler Owners in Berlin, June, 1930. Brief reference is also made to a paper by Dr. W. H. Hatfield read at the recent Prague meeting of the Iron and Steel Institute.

Special interest attaches to the papers dealing with operating experiences on steam boilers presented at the 19th general meeting of the German Association of Boiler Owners (Die Vereinigung der Grosskesselbesitzer E.V.) held in Berlin last June. It was pointed out that the actual stress in the material might be much higher than that calculated in the usual manner, an example being given of a 4-ft. 3-in. internal-diameter drum of a vertical-tube boiler, with a wall thickness of 2¼ in. In such a drum, with steam at 37 atmos. (526 lb. per sq. in.) the internal pressure would cause a stress of about 4.6 tons per sq. in. When allowance is made for the additional stresses due to expanding the tubes into the drum and heat transmission at the rate of only 4000 B.t.u. per sq. ft. per hr.—necessitating protection of the drum by about 3 in. of firebrick—the total stress was calculated by Dipl.-Ing. Lupberger as approximately 10.8 tons per sq. in. This high stress certainly occurs only at the edges of the holes in the inside of the drum, but it emphasizes the necessity of limiting any further increase by reason of stiffness of the boiler tubes, irregular heating, faulty erection, etc. Defective water circulation, permitting the formation of the steam which is trapped in the tubes with consequent overheating, led to failure from corrosion by interaction of the iron and steam. Measurement of the temperature of the steam at the outlets of several superheater elements of an 11,000-sq. ft. vertical-tube boiler revealed a range of from 380 deg. cent. to 520 deg. cent. with an evaporation of 60 tons per hour. Obviously, since the material has to be able to withstand the maximum temperature, while

it is only the average temperature which is of value in the subsequent use of the steam, these variations should be reduced to a minimum by attention to the firing and to the circulation of water and steam. The vital importance of this is shown by the rapid fall, in this temperature range, of the limiting creep stress, which, at 500 deg. cent. for mild steel with 0.16 per cent carbon, is only some 25 per cent of the value (4.6 tons per sq. in.) at 400 deg. cent, while for 5 per cent nickel steel it is about 28 per cent of the value (10.8 tons per sq. in.) at 400 deg. cent. Above 500 deg. cent. the difference in strength between the various carbon and nickel steels rapidly becomes negligible, due to the structural changes in the materials, the distinct advantage indicated as possessed by 5 per cent nickel steel at 600 deg. cent. being no longer present. That boilers have worked for long periods at steam temperatures of over 500 deg. cent. (the tube temperature being in the neighborhood of 500 deg. cent.) with steam pressures up to 2400 lb. per sq. in. is simply in the line with the American experience referred to above.

Investigation is continually proceeding with a view to the production of materials which will give greater strength at these high temperatures, with less liability to corrosion. Both of these properties are possessed to a high degree by certain of the heat-resisting steels, alloys of nickel, chromium, and tungsten. Unfortunately, these materials do not lend themselves to the manufacture of boiler and superheater tubes. Recent developments in the use of steels containing molybdenum appear to indicate considerable possibilities, the creep-stress tests showing about double the value at 500 deg. cent. that is obtained with nickel steels, and also a much lower rate of decrease. Tubes of this material are to be used for the radiant-heat superheaters of Löffler boilers, and the results of practical experience will be awaited with interest. (*Engineering*, vol. 130, no. 3381, Oct. 31, 1930, pp. 544–545, *g*)

Corrosion of Light and Extra Light Metals and Alloys

THE following is based on a report of the Subcommittee on Light and Extra Light Alloys of the Society for the Encouragement of National Industry in France. The first part deals with the effects of arsenic when present in this type of alloy. The investigation was made by introducing arsenic into aluminum and its alloys, both alone and in combination with the special elements entering into the composition of duralumin, especially copper and manganese, the effect of iron being considered in this particular connection as negligible. Both, high and low arsenic contents were considered. In making alloys of the duralumin type it was found that considerable amounts of arsenic segregate and remain at the bottom of the crucible. The duralumin ingots were subjected to various heat treatments. Duralumin made in the ordinary manner, i.e., without arsenic, could be rolled without difficulty. On the other hand, arseniated duralumin showed a clear tendency toward cracking in rolling, and could be rolled successfully only when the reductions per pass were very small and the reheatings frequent. To avoid the volatilization of the arsenic the rolling had to be conducted at a temperature not exceeding 400 deg. cent. (752 deg. fahr.). In physical tests it was found that the effect of arsenic on duralumin is expressed by a slight reduction of the elastic limit, tensile strength, and elongation in the direction of rolling. In the direction normal to rolling, however, the reduction of elongation has been less noticeable. It does not therefore appear that the presence of a little arsenic in duralumin materially affects its mechanical properties. Neither was there discovered a greater tendency of the arseniated duralumin to be attacked on exposure to the action of sea water. [The preceding part of the report was written by R. Cazaud. The next part, dealing with methods of protecting the surface of aluminum against chemical actions, was written by A. Trillat.]

The main method of protection investigated has been the application of greasy materials. In itself this is a well-known process, but the present investigation has shown that certain greasy materials have a higher adherence to metal and resistance to external agents than others. In this respect the so-called "hardened" oils, which means hydrogenated oils, proved to be of particular interest, and among them the ones that attracted particular attention were soya oil, cottonseed, sesame, and fish oil alone or mixed with a small amount of lanolin. It is interesting to note that in one of the series of tests (at the Laboratory of the Centre d'Études in Toulon) some test plates were completely perforated by corrosion. An investigation has shown that in this case, in order to facilitate observation, a metallic pigment was added to the greasy material and this apparently formed an electric couple with aluminum, causing the decomposition of the grease through saponification.

On the other hand, Trillat found that in the course of time the hydrogenated oils lose some of their flexibility, partly because of a certain degree of saponification. As a result of this the grease coating cracks, and this promotes local corrosion. This is said to have been obviated by the addition of a small amount of lanolin to the grease. Also the coating of grease should not exceed a certain thickness, as otherwise cracks will occur.

In the course of tests intended to check the above considerations, several interesting things have been found. One of them is the resistance offered by the coatings of grease to water friction. The author describes just how these tests were made. They showed that after several months of immersion the portions of the test pieces covered by the grease were intact, while the portions not greased were very much worn by the action of water and the sand which it contained. In this case only mechanical and not chemical action was observed. All of these tests were made by simple immersion in sea water. They were followed by a series of tests using a powerful jet. Dry aluminum plates and greased plates were exposed to the action of the jet at various distances from the nozzle, with the result that it was found that the thin coating of solidified grease always remains intact. This result was all the more startling, as the coating of solidified grease could be easily removed by wiping it with a rag.

After explaining the theory of this phenomenon, Trillat expresses the opinion that the hardened greases tested out on aluminum plates can be used for preserving parts against corrosion induced by water friction. This would apply to the case of propellers, turbines, ships' hulls, and hydroplane floats. Greasing the hulls of vessels and floats, in addition to insuring them against corrosion, might also facilitate gliding through the water and reduce the coefficient of resistance to forward motion. Certain tests were made to determine the ability of the grease layer to adhere to polished and non-polished aluminum. This adherence proved to be remarkably great, not withstanding the power of the jet and the angle at which it was directed. In the case of a wooden plate 1 cm. (0.4 in.) thick the jet split the plate but did not wash the grease away.

The application of the "phenol process" for the protection of light aluminum alloys is discussed by Aubert and A. Pignot. In this the surface is first cleaned and then covered with a priming coat consisting of pitch, phenol, and gasoline prepared in a special manner. This is followed by drying during a period of 48 hr., whereupon a second coat of the same mixture applied and likewise dried for 48 hr. A coat of aluminum paint may be then applied for the sake of appearances. The mixture consists of 30 per cent of dry pitch, 5 per cent of crude phenol, and 65 per cent of 90/160 gasoline. The complete specification for these materials is given in the original article. The pitch is melted

in an oil bath until the mass becomes completely fluid. It is then cooled to about 80 deg. cent. (176 deg. fahr.) whereupon the phenol is added while the mixture is being stirred. The gasoline is added when the mixture reaches from 60 to 70 deg. cent. (140 to 158 deg. fahr.). It is important that no open flame be allowed in the neighborhood when the gasoline is being added. The whole mixture must be worked to good homogeneity. If the mixture is stored, this should be done in a room where the temperature does not exceed 20 deg. cent. (68 deg. fahr.).

There is an advantage in using the mixture not more than two months after its preparation.

Tests on the resistance of variously coated duralumin plates to the action of natural sea water are reported by Quillard. The tests were made in the first place with silicate of soda as a protective medium. A protected and a bare plate were used, and it was found that the deposits on the protected plate were smaller in volume and thinner and did not form a complete coating as in the case of the unprotected plate. The second series of tests were made with the same coating, but after activation of the aluminum plate by a $^1/_{1000}$ solution of bichloride of mercury for 20 min. The idea underlying these tests was that nascent aluminum forming on the surface of the activated metal might combine with the silicon, forming a coating of silicate of aluminum which would be insoluble. The results were disappointing as the deposits were heavier than on the non-activated plate. On the other hand, sandblasting previous to silicating the plates improved the result. It was found, however, that the behavior of the activated plates was different from that of the non-activated, which shows that the subject deserves further consideration. The original paper also reports some additional tests on the action of sea water, while Engineer Lecouvre draws certain conclusions from tests at the Centre of Practical Studies for Naval Aviation at Saint Raphaël in 1926 and 1927. He gives tables which present some of the details of methods used in preventing corrosion, as well as general observations. It has been found that good results are given by nitrocellulose varnish, provided it is applied not directly to the metal but to some coating strongly adhering to the metal. The protection by a coating of cadmium deposited by the Schoop process likewise proved to be good. The same material deposited electrically seems also to give good results, but the author believes that deposition by the hot process is more convenient in practice. He suggests tests on caissons with cadmiumized rivets. Another promising development is the application of a coating of cadmium and over it another of Aubert's varnish or nitrocellulose varnish or of suitable grease.

The use of a zinc plate intended to deflect to itself the corrosion action did not prove as satisfactory on a large scale as it did with small pieces. This may be due to improper location of the zinc sheets, or insufficient size or some other reason. The deposition of intermittent bands of zinc on duralumin by the Schoop process to obtain the same result deserves further consideration, and similar tests might be undertaken with cadmium. A brief reference is made to the anodic process.

(The part abstracted here is the second part of the Memoires published in *Revue de Métallurgie*, vol. 27, no. 7, July, 1930, pp. 337–351, 20 figs., numerous tables, *eA*)

GAS ENGINEERING

Tracy-Crockett Section, Kettleman Hills-Richmond Natural-Gas Pipe Line

THIS California undertaking is interesting both because of its size and the rapidity with which it was executed. The section is 46 miles long, consisting of 27 miles of 26-in. high-carbon welded steel pipe $^5/_{16}$ in. thick in 40-ft. lengths weighing 3404 lb. per length, and 19 miles of 22-in. pipe of the same wall thickness and specification weighing 2896 lb. per length. Ten miles of the line is protected against corrosion by a special asphalt mastic.

The new line has a present daily capacity of 138,000,000 cu. ft. of natural gas and an ultimate capacity of 200,000,000 cu. ft. per day. It is said to be the largest and heaviest pipe line of the type to be laid in the United States to date. All pipe was manufactured by the A. O. Smith Corporation, Milwaukee, Wis., and shipped by rail. The necessary pipe protection was applied at the storage yards. Welding of the main joints was done with electric arcs, using portable Smith generators. Caterpillar tractors equipped with side booms and a Bucyrus crane were used to handle and lay the strings of pipe.

Previous experience on the recently constructed pipe line from Kettleman Hills north, where some sections of pipe were seriously pitted from soil corrosion before the line was completed, showed the necessity for developing a more dependable protective coating. An asphalt mastic was accordingly developed by the Standard Oil Company especially for this line. It is composed of sand, mineral dust, and asphalt, and is similar to floor and sheet-asphalt paving. No equipment for placing the coating was available before the project was planned, so it was designed, assembled, and put in operation within one month. The mastic was rolled on by machine from a hopper. Use of the coating increased the weight of each length 40 per cent. and made the handling problem more difficult.

To be safe and stable, the pipe line had to fit the trench accurately so that movements resulting from temperature changes or other stresses would not be localized at the bends, with resulting overstress and possible rupture.

The pipe was of large diameter and thin wall, and could not be bent in the field without buckling. Accordingly two types of joints were devised to care for changes in alignment and grade. For large angles, miter joints were cut and acetylene welded. Other angles up to 12 deg. were made with Smith wrinkle-belly joints. These joints are shaped like an accordion and contain three corrugations. They were formed in the shop, inserted in the field by electric welding, and assumed the proper angle when the line was lowered into the ditch. These wrinkle-belly joints were used in the great majority of cases and were quickly applied.

Remarkable speed was made on the contract. Deducting rainy days, the average of all operations was 0.4 mile per day.

Two Ingersoll-Rand 310-c.f.m. portable compressors mounted on 5-ton Sterling trucks were used to furnish air for the initial and second tests of the line. The initial or soap test was made on 1-mile sections above ground and consisted of coating the joints with liquid soap, applying an air pressure of 100 lb. per sq. in., and inspecting the joints for bubbles. The second test was far more severe and was made on 3-mile sections after the pipe had been lowered. With an air pressure of 100 lb., and gages set along the line, the pipe was required to show no appreciable loss in pressure for 24 hr. The final test was made after completion of the line, and consisted in applying 400 lb. pressure with natural gas. (*Western Construction News*, vol. 5, no. 19, Oct. 10, 1930, pp. 489–492, illustrated, *pd*)

HYDRAULIC ENGINEERING

Flow of a Viscous Fluid Through a Tube Containing Another Tube of a Smaller Diameter

THE present article is an abstract of a publication of much larger scope, to be printed as a separate issue of the Proceedings of the G.I.N.I. Only the final formulas are published here. The proofs are available in the larger publication. For the case of stabilized laminar flow of a viscous liquid in a pipe of radius

R, the output Q in cubic meters per second (which means the amount of liquid passing per unit of time through the entire section normal to the radius of the tube) can be expressed as follows:

$$Q = \frac{\pi}{8} \times \frac{ghR^4}{\nu l} \quad [1]$$

where $h = \frac{p_1 - p_2}{\gamma}$ is the drop of pressure and p_1 and p_2 are respectively the pressures at the beginning and the end of a pipe of length l, γ is the weight of a unit of volume of liquid, $g = 9.81$ m. per sec. per sec., and ν is the coefficient of kinematic viscosity.

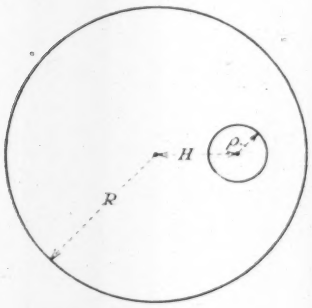

FIG. 1 CROSS-SECTIONAL VIEW OF A PIPE WITHIN WHICH A SMALLER PIPE IS LOCATED ECCENTRICALLY

The average velocity V in m. per sec. is

$$V = \frac{Q}{\pi R^2} = \frac{g}{8} \times \frac{hR^2}{\nu \times l} \quad [2]$$

H. Lamb in "Hydrodynamics," 5th edition, 1924, pp. 554–555, gives formulas for the velocity of flow and output for a case where within a pipe of R is placed a concentrically located pipe of a smaller radius ρ. The output in this case is

$$Q = \frac{\pi g}{8} \frac{h}{\nu l} \left(R^4 - \rho^4 + \frac{(R^2 - \rho^2)^2}{lg \frac{\rho}{R}} \right) \quad [3]$$

For the case where the inside tube is not located concentrically no solution is given, and yet the problem is of importance, particularly in connection with heat exchangers used in the flow of oil where a small pipe is placed in the large one to heat the oil. The present author has obtained the exact solution of this problem for the case of one centrally located pipe. By solving the differential equation of flow for given limit conditions, he obtained an expression for the output of flow given in the original article as formula [4] which is very clumsy and unsuitable for practical work. By using certain approximative methods, however, he has obtained the following more convenient formula:

$$Q = \frac{\pi g}{8} \times \frac{h}{\nu l} \left[R^4 - \rho^4 + \frac{(R^2 - \rho^2 - H^2)^2}{lg \frac{R\rho}{R^2 - H^2}} \right] \quad [5]$$

The average velocity can be obtained by dividing the output of flow as given in formula [3], [4], or [5] by the area of the cross-section $\pi R^2 - \pi \rho^2$. Formula [5] does not, of course, give exactly the same results as the more elaborate but correct formula [4], but the values which it does give approach the closer toward the values obtained from formula [4] the smaller ρ and H are. The latter, as shown by Fig. 1, is the distance between the axes of the two pipes. If $H = 0$, i.e., the pipes are concentric, formulas [5] and [4] become formula [3], and if $\rho = 0$, then formula [5] becomes formula [1].

The original article contains a table giving coefficients K and K_1 depending on variations of radius and location of the inside tube. This table shows how the output of flow through the main pipe varies as a result of the introduction of the smaller pipe. The author gives an illustrative calculation which is not reproduced, largely because to comprehend it probably would require reference to the above-mentioned table, for which there is here no space available. He also solves the problem for any number of internal tubes located in any manner whatsoever, and gives a formula for the case where all the internal tubes are located with their centers on a circle concentric with the main tube. (V. N. Shchelkacheff, in *Petroleum Industry* (Russian), vol. 19, no. 7, July, 1930, pp. 96–98, 3 figs., *mpA*)

INTERNAL-COMBUSTION ENGINEERING

A Coal-Dust Diesel Engine

PREVIOUS reference to this engine developed by the German engineer Rud. Pawlikowski has been made in the technical press. One such unit, a 80-hp. single-cylinder vertical engine, was built in 1924 and since then has had 9000 hours of operation on bituminous coal, brown coal, charcoal, peat, wood shavings, coke breeze, rice hulls, and flour-mill refuse. The cylinder lining has worn out, but the compression is still 30 atmos. and the ignition is reliable. The piston rings were changed ten times.

In addition to this several Diesel engines have been rebuilt by the firm Kosmos to use powdered coal, among these being a vertical four-cycle 100-hp. two-cylinder engine. It is claimed that (1) the steady ignition of coal dust is assured by compression to 32 atmos.; (2) the fineness of pulverization required is the same as that for boiler firing, but a somewhat finer pulverization is advantageous; (3) the injected particles of coal burn up completely, without tar formation, and the residual particles of ash do not fuse together but leave the cylinder suspended in the gas. The oiled cylinder lining is free of slag under any conditions, as also are the cylinder cover, the inlet valves, and the combustion chamber. Several means have been found and tested to keep the piston and the exhaust valve free from slagging. (From abstract of a pamphlet published by Pawlikowski, *g*. Original pamphlet not at editor's disposal.)

Horizontal Diesel Engines

SUCH engines, in two units of 1500 hp. each, have been installed in the power plant of the pumping station at Puento Chico in the province of Buenos Aires, Argentina. Each unit consists of a horizontal four-stroke-cycle Diesel engine with airless injection and two double-acting cylinders arranged in tandem and driving directly from the crankshaft an electric generator. The entire plant was built by the Skoda Works, of Pilsen, Czechoslovakia.

The Diesel engines, Fig. 2, have a bore of 850 mm. (33.46 in.) and a stroke of 1250 mm. (49.21 in.), and run at 125 r.p.m. Only one piston rod is provided, to which both pistons are connected. This piston rod is supported in two places, namely, in the crosshead and in guides between the two cylinders so that the pistons do not bear on the cylinder surfaces, as compared with the construction of other tandem cylinders with two piston rods, a coupling, and three guide surfaces where the masses can be balanced only imperfectly because of lack of space available for counterweights. The construction adopted in this case offers the possibility of reducing the reciprocating masses to such an extent as to permit running the engine at a higher speed. It is also claimed that the elimination of the fourth stuffing box and rear guide improves the mechanical efficiency of the engine.

The frame is a single casting, but can be made in two parts if necessary for the sake of transportation. It is provided with cast-steel crankshaft bearings which are lined with white metal. The main-bearing bushings are made in three parts and can be removed without dismantling the crankshaft. The cylinders consist of two symmetrical cast-steel jackets shrunk on a hard cast-iron liner and connected with each other by stout flanges. By

giving the cylinders the proper shape, dangerous heat stresses are said to be avoided. In each half of the cylinder the following accessories are installed: At the top the inlet valve and at the bottom the exhaust valve, and four fuel-admission valves inclined at an angle of 45 deg. At the rear end of each cylinder there is a valve for starting the engine with compressed air. The housings of the exhaust valves are so designed that the expansion of the cylinders by heat does not distort the water-cooled valve seats. In order to install and dismantle quickly the exhaust valve housings a special lever is provided which makes it unnecessary to use a traveling crane.

The cooling water goes first to the exhaust-valve housing, then into the cylinder jacket, and finally into the cylinder head. All the outlet pipes are joined on the rear cylinder head and are plainly visible.

The cylinder heads are bodies of rotation made of annealed steel castings and not ribbed. Except for the rearmost one, the heads have only a central orifice for the packing gland. It is

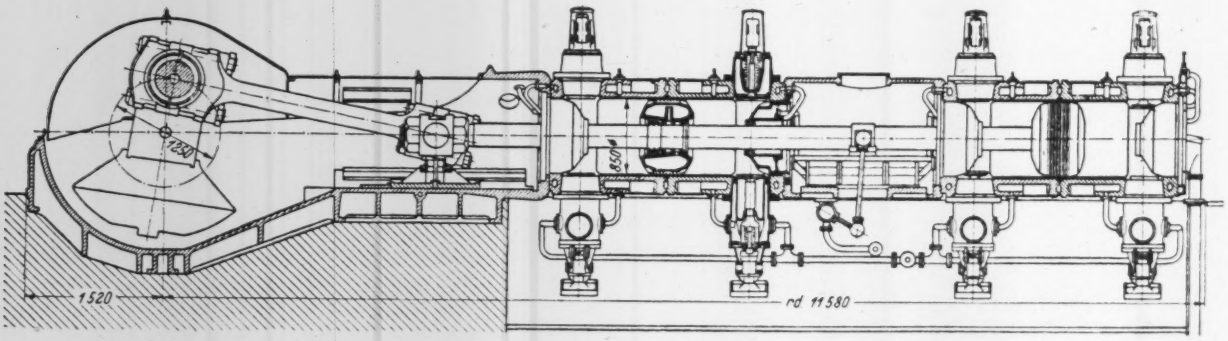

FIG. 2 LONGITUDINAL SECTION THROUGH THE HORIZONTAL DIESEL ENGINE AT THE PUENTO CHICO PUMPING PLANT, PROVINCE OF BUENOS AIRES, ARGENTINA, S. A.

claimed that in this way dangerous local heat expansions are completely eliminated. The pistons likewise are not ribbed and are made of the same material as the cylinder heads. A reciprocating pump located in the basement provides cooling water for the pistons. This water comes from a well and enters the hollow piston rod through simple joints made of non-rusting material for which no regular lubrication is necessary.

As is the practice with large gas engines, the camshaft is driven from the crankshaft through an intermediate shaft. On the camshaft the following parts are located: shaft governor, the cams operating by means of tappets; the inlet and exhaust valves; the drive for the compressed-air starting device, the oil lubricating presses, and finally the cams for driving the fuel pumps. All of these devices are of horizontal construction and are attached on both sides of the camshaft bearing blocks. The pistons of the fuel pumps are ground in their bearings, and ordinarily the valves are made of acid-resisting material. The governor operates on the suction valve and acts by changing the beginning of the fuel injection. The injection valves are spring-loaded needle valves lifted by the pressure of the pump, and the fuel is injected into the combustion chamber directly, i.e., without the employment of an antechamber. The original article gives a Horn tachogram taken on the crankshaft and intended to show the excellent governing of the engine. The engine and generator set working at full load suddenly had the load completely thrown off by the main switch on the switchboard. As a result of this the revolutions of the engine suddenly jumped 3.5 per cent, but after a period of oscillation continuing for 25 sec. at a speed 1.75 per cent higher than before, came to a new condition of equilibrium. Under ordinary conditions the engine speed is controlled either directly at the engine by hand or through an electric motor from the switchboard

The cylinders and stuffing boxes are lubricated by means of pressure pumps, the output of which can be exactly controlled. The other movable parts of the engine, such as eccentrics, tappets, cams, etc., are taken care of by separate lubricating pumps. The lubrication of the crankshaft drive is of the circulating type. A gear pump driven from the camshaft feeds an elevated tank from which the oil flows into the hollow crankshaft and under the crosshead shoe. The two main bearings, the connecting-rod, and the external bearing are lubricated through holes bored in the crankshaft. The used oil then passes down into a reservoir in the basement, whence it is pumped up into the elevated tank by the gear pump above referred to. This provides ample lubrication and has the advantage that the lubricating oil cannot be contaminated by either water leaking through the joints or carbon forming in the cylinder oil.

As shown by a diagram in the original article, the starting of the engine is simple and takes place without undesirable rise of pressure. The diagram shows that the maximum ignition pressure at the beginning of the admission of fuel does not reach the 37 atmos., which is the normal operating pressure at full load. Starting is effected as follows: Compressed air is admitted into the second and fourth combustion chambers, counting from the crankshaft. As soon as the engine begins to turn over, fuel is admitted into the first and third combustion chambers. After two strokes the compressed air is cut off and fuel is injected into the other two combustion chambers. After some 40 to 50 seconds the engine with its eight injection valves attains its full speed, whereupon the other eight injection valves are cut in and the dynamo can be connected in parallel and take up the load. Even on very cold days no trouble is experienced in starting the engine. Interconnections are provided to prevent improper starting.

The original article gives data as to the consumption of fuel and cooling, as well as efficiencies of the current generator. The consumption at full load referred to useful output is said to be as follows: Fuel, 172.7 gr. (0.38 lb.) per hp-hr.; cylinder oil, 0.562 gr. (1.236 lb.) per hp-hr.; lubricating oil 0.295 gr. (0.645 lb.) per hp-hr.; and cooling water 33.3 cu.m. (8795 gal.) per hr. All of this with an inlet temperature of 18 deg. cent. (64.4 deg. fahr.) and as outlet temperature of the cylinder head of 58 deg cent. (136.4 deg. fahr.), and at the pistons, 38 deg. cent. (100.4 deg. fahr.).

The engines have on several occasions been overloaded to the extent of 12 per cent for periods in excess of 1 hr. The exhaust up to an output of 850 kw. was completely invisible. At full load a light grayish smoke appeared, which became darker at

overload. (Engr. Josef Kremzar in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 74, no. 42, Oct. 18, 1930, pp. 1441–1442, 5 figs., *d*)

A Rotary Opposed-Piston Engine

THIS engine was designed by A. Roger in England and has a rotating single cylinder in which work two opposed pistons driving two crankshafts at opposite ends thereof. The crankshafts are geared to a stationary wheel, with the result that the engine as a whole rotates, and its rate of rotation in relation to the revolutions of the two crankshafts is governed by the gear ratio employed. As the whole of the engine rotates, no separate flywheel is needed.

Gas is fed to the cylinder through the trunnion on which the engine rotates, it being distributed through ports cast in the cylinder. The exhaust also passes out similarly, after circulating

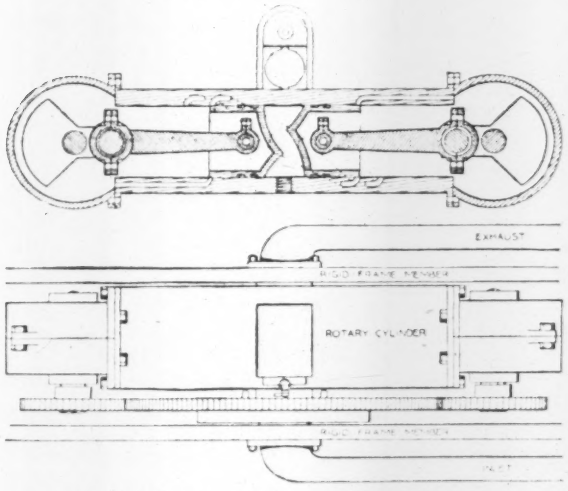

FIG. 3 THE ROGER OPPOSED-PISTON ENGINE

through an expansion chamber secured to the cylinders; by this means the gas is cooled sufficiently (since the silencer rotates with the engine) to pass through the trunnion on the exhaust side without unduly heating the ball bearings. It will be realized that the engine, by virtue of its rotating principle, is air cooled.

Magneto ignition is employed, the drive being by chain from one of the crankshafts. Power is taken off from the exhaust side by a reduction gear. Lubrication is introduced at the cylinder walls and is circulated to the crankcases centrifugally. Ball and roller bearings will be used in the finished design.

High efficiency from the engine is anticipated by virtue of the opposed-piston design, while the weight should be low. It is hoped to develop the engine for compression-ignition working, for which the general cylinder arrangement appears favorable, and the heavy cylinder and crankcase required would merely add to the flywheel weight of the engine and therefore would be no great disadvantage.

Examination will reveal that if the large gear ring meshing with the two crankshaft gears is released, the engine as a whole will cease to revolve; a simple clutch in this wheel therefore provides a self-contained transmission clutch which may be considerably lighter in construction than a normal clutch. Furthermore two or three or more gear ratios (or more correctly, torque ratios) can be arranged in this way by using gears of different ratios, each having its own friction clutch, thereby providing an easy and shockless changing mechanism. (*Motor Transport*, vol. 51, no. 1336, Oct. 20, 1930, p. 450, 1 fig., *d*)

METALLURGY

Influence of the Chemical Composition of Melt on the Physical Properties of Malleable Cast Iron

THE chemical composition of malleable cast iron is primarily affected by the type and method of operation of the melting furnace. The composition that is said to give a high tensile strength and good elongation is as follows: Total carbon, 2.2 to 2.4 per cent; graphite, 0.0 per cent; silicon, 0.6 to 1.0 per cent; manganese 0.2 to 0.3 per cent; phosphorus, 0.1 per cent; sulphur, 0.04 to 0.06 per cent; and as little as possible oxygen and gas inclusions. The contents of silicon, manganese, and phosphorus can be regulated as desired in any melting process, but the contents of carbon and sulphur depend not only on the type of furnace used but on the skill of the melter and very largely on the quality of the fuel. It is said, for example, that the low contents of carbon and sulphur indicated above cannot be obtained with the cupola furnace. As regards the influence of the carbon content, the author refers practically exclusively to American practice. Silicon affects favorably not only the formation of the temper carbon but also the constitution of the metallic matrix by raising the tensile strength and elastic limit of the iron. In a general way it may be said that an increase of silicon content to the extent of 1 per cent raises the tensile strength and elastic limit by about 1 kg. per sq. mm. (1422 lb. per sq. in.) The viscosity of the metal is not affected by the silicon content provided it does not exceed 1 to 1.2 per cent, assuming, however, that the percentage of silicon as compared with the contents of other constituents is not high enough to produce a precipitation of graphite.

As regards manganese in malleable cast iron, the tendency formerly was to keep it as low as possible. Of late, however, it has been found its content should be regulated in accordance with the type of iron. In the case of crucible, air, and open-hearth furnaces where the sulphur is low the manganese should not exceed 0.18 per cent, if it is desired to obtain a malleable iron with a white fracture without black heart. If, however, a black heart is desired, then the manganese ought to be about 0.25 per cent, as manganese of that content assists in the separation of temper carbon during annealing. In the case of cupola melts, the manganese content ought to be higher to counteract the unfavorable effect of sulphur.

In iron rich in sulphur and poor in manganese, the sulphur combines with the iron to form iron sulphide which opposes the separation of temper carbon and thereby strongly retards the annealing process. If, however, the manganese content is raised the sulphur combines with the manganese, and the manganese sulphide thus produced is harmless in so far as the annealing process is concerned. To convert all the sulphur into a manganese compound it is necessary theoretically to have 1.7 times the manganese per cent, so that if we assume the cupola iron contains 0.18 to 0.2 per cent sulphur, it would be necessary to have at least 0.3 to 0.35 per cent manganese in order to make all the sulphur harmless. For white-fracture malleable iron it is worth while to have that much manganese. If, however, black heart iron is being melted in a cupola, it becomes necessary to have an excess of manganese, and with the sulphur content given above of 0.04 to 0.06 an effort should be made to obtain a manganese content of 0.55 to 0.6.

This method of raising the manganese content (previously unknown) results in certain advantages. By making easier the breakdown of combined carbon (cementite) it becomes possible to avoid hard spots and porosity on the inside of the casting which were so frequently found before; the physical properties of the metal are materially improved; the manganese sulphides formed in the metal, because of their high temperature of solidifi-

cation, do not pass off into the slag and a certain desulphurization of the metal is thus obtained. Manganese also improves the tensile and transverse strength of the metallic matrix without affecting undesirably its elongation and produces an increase in tensile strength of 0.8 kg. per sq. mm. (1138 lb. per sq. in.) for each increase of 0.1 per cent of manganese. By eliminating sulphide strings in the metal it also improves the strength of metal, particularly against shocks. The author illustrates this by micrographs and sulphur prints.

Among other things, the author points out that the soda-ash process of desulphurization of cupola metal, which works well with gray iron, causes trouble with malleable iron.

For deoxidizing the melt either pure aluminum or an aluminum-titanium alloy may be used. If aluminum is used it should go over completely into the slag, and an excess of the deoxidizing metal should be avoided because the presence of aluminum promotes the separation of coarse graphite. Titanium acts as a powerful deoxidizing and degasifying metal, particularly with respect to nitrogen, and powerfully promotes the formation of graphite and temper carbon. It is effective even when present to the extent of 0.1 to 0.2 per cent. When iron-titanium alloy is used, however, it is difficult to introduce into the metal bath exactly the right amount, and this is possible only when an aluminum-titanium alloy is used. On the other hand, the author considers additions of nickel, uranium, and zirconium as dangerous, and believes that none of them have been completely successful in improving malleable cast iron; and that foundries which have succeeded in producing material to satisfy standard specifications do not need any special processes to improve metal, provided it is properly melted. (Dr. of Engrg. Rudolph Stotz, in *Zeitschrift für die gesamte Geissereipraxis*, vol. 51, no. 30, July 27, 1930, pp. 261–263, *p*)

MOTOR-CAR ENGINEERING

The New German DKW Car With a Two-Cycle Motor

THE original DKW automobile had a two-cylinder, two-stroke-cycle engine. On the new car the two-stroke cycle has been retained, but a four-cylinder engine has been installed. The engine, however, is not a straight-in-line but a 90-deg. V-type with two cylinders on each side. Each side is supplied with an independent double-acting charging pump, the purpose of which is to provide a slight degree of supercharge. The present article does not describe in very much detail the car or the engine, but gives data of tests and impressions of the ability of the car to be handled in traffic. From a table in the original article it would appear that the new DKW is a four-passenger car and the engine at 3500 r.p.m. develops 22 hp. on the brake, giving 2.9 hp. per 100 kg. (2200 lb.) of weight, including load.

The method of testing selected by the author was based primarily on obtaining acceleration curves such as those shown in Fig. 4 (in meters per second per second). These curves have been drawn for the three speeds, and the author claims that they tell practically everything worth knowing about the operation of the car. As an example of his analysis the following discussion of the third or high speed is referred to here. In the first place, it permits running at speeds of from 10 to about 80 km. (49.7 miles). The curve runs quite steeply at first, which indicates a moderate starting acceleration. In the majority of four-stroke-cycle motors the initial point of the acceleration curve is considerably higher. This peculiarity of the two-stroke-cycle motors is found in the new DKW car as well, although the action of the pump in the direction of improving the charging shows up even in the lower revolutions. From a speed of 25 to 60 km. (15.52 to 37.28 miles) the curve is remarkably flat, which shows that in that wide range the car acts in an ideal way. The absolute height of the curve is less desirable. In the range of speeds given it shows accelerations of from 0.4 to 0.48 as compared with 0.6 in the case of the average commercial car. The slow ascent of the curve is well worth attention, as it shows that this little $^3/_4$-liter motor is sufficient to drive a car weighing 750 kg. (1650 lb.) at a speed in excess of 80 km. (49.7 miles). From this point of view the DKW compares favorably with cars $2^1/_2$ times as large and equipped with four-stroke-cycle engines.

The curve for the second speed differs very little from those of a good four-stroke-cycle motor, and the same applies to the acceleration curve in first. The maximum acceleration is in excess of 1.4 m. (4.55 ft.) per sec. per sec., a value which few 2-liter automobiles can show in this speed. This shows that the first speed can be used up to a running speed of the car of 30 km. (18.6 miles). On the whole, these curves show a very

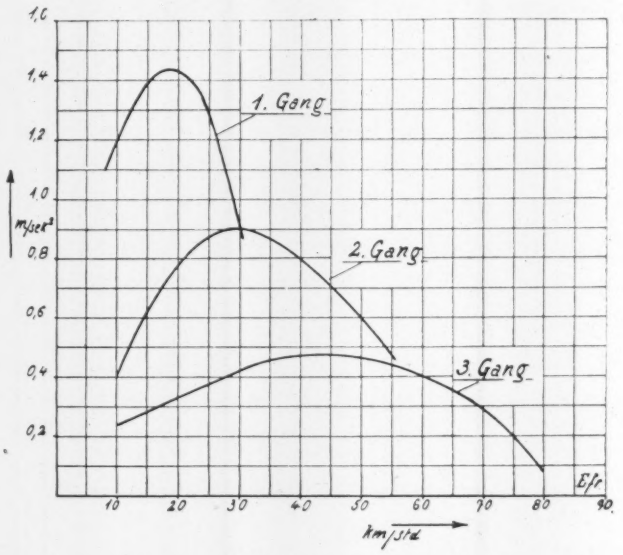

Fig. 4 Acceleration Curves of the Four-Cylinder Two-Stroke-Cycle German DKW Automobile

powerful first speed, a normal second speed running, and a somewhat sluggish high speed, all compared to the standard 2-liter car. This the author considers to be very remarkable and to promise well for the future of the two-cycle car. In order to give this car the full capacity of a four-passenger car, it would have been necessary to increase the stroke volume of the motor by about 200 to 250 cu. cm. (12.2 to 15.2 cu. in.) or to equip with a fourth speed, which the author thinks would have been more advisable and economical. The author concludes by giving a careful comparison of the old two-cylinder car with a new four-cylinder. (Engineer E. Friedlaender in *Automobiltechnische Zeitschrift*, vol. 33, no. 16, June 10, 1930, pp. 390–392, 2 figs., *de*)

A Steam Wagon With Special Wheeling

THIS is a description of the new type D.G. 8 Sentinel steam wagon built at Shrewsbury, England. One of the interesting features is the fact that the road wheels are carried on two independent four-wheeled oscillating bogies, which, it is claimed, give to the vehicle the quality of easy riding on the roughest roads.

The front axle consists of a fixed hollow forging mounted on long, flexible springs and located by means of radius rods and shock absorbers to allow of free vertical movement.

On each end of the front axle a forged steel double-armed bogie frame is pivoted, the outer ends of which carry steering

pivots in which the front-wheel journals rotate. Each of the pivots is connected by a track rod to its "opposite number" through levers set to the correct angle, while the front and rear pairs of wheels are coupled together by means of a secondary drag link; the primary drag link being connected to a transversely mounted drop arm at the base of the steering column.

Owing to the additional adhesion provided by the four wheels, the leading pair can be given a greater lock than usual without any tendency to skid forward when turning. The radius of the circle in which the D.G. 8 will turn is also less than that of a vehicle of the same wheelbase having only two front wheels. Again, all the front wheels move together to the correct angle and roll along arcs of circles having their center at the point which the vehicle is turning; this accounts for the remarkable ease with which the vehicle can be maneuvered. (*The Quarry and Roadmaking*, vol. 35, no. 404, Oct., 1930, pp. 390–391, 1 fig., *d*)

PETROLEUM ENGINEERING

Hydrogenation of Petroleum

THE article here abstracted deals with some of the recent developments in the hydrogenation of petroleum and shows the adaptability of the process for converting fuel oil to gasoline and gas oil, as well as increasing the paraffinic nature of kerosenes, burning oils, and lubricants. It also discusses the reverse possibility of producing non-paraffinic gasoline. In this process the charging stock together with sufficient hydrogen is pumped into a reaction vessel containing catalysts, where at the desired temperature and at about 3000 lb. per sq. in. pressure the reaction is allowed to take place. Hydrogen may be produced by any of the usual processes, particularly as it does not have to be free from sulphur. From the reaction chamber the combined final products and gases pass through heat exchangers and coolers to a high-pressure separator where the liquid product is separated from the unconsumed hydrogen and other gases.

The economic side of the process is barely touched upon. It would appear from the data in the article, however, that because of the existing oversupply of crude oil, hydrogenation in its present state of development in this country may be considered as being supplementary to other existing refining methods. It may supplant them if and when the supply of crude oil and the demand for light products approach a balance. From an engineering point of view an interesting feature of the hydrogenation process is its ability to produce stable low-knock gasolines.

Furthermore asphaltic crudes of all sorts and residues from refractory crudes, as well as cracking-plant tars, can be converted to distillate products free from asphalt and low in sulphur with volumetric yields in excess of 100 per cent. The hydrogenation process therefore offers the oil industry a means of confining its production of heavy fuel to its economic market demand, and a means of balancing crude production against the demand for refined white products, gasoline, Diesel fuels, burning oils, and the like, independent of the natural, heavy-fuel content of the crude.

From mixed-base crudes highly paraffinic products such as gas oils, burning oils, and lubricants may be produced. On the other hand, from paraffinic crudes so-called aromatic products may be formed, as, for example, a highly anti-knock gasoline from a very paraffinic gas oil. Even from the same gas oil paraffinic burning oil and anti-knock gasoline may be made. Consequently, from any given supply of crude the products of the quality desired may be produced by refineries employing hydrogenation. (R. T. Haslam and R. P. Russell, the former with the Standard Oil Development Co. and the latter with the Hydro Engineering & Chemical Co., both of Elizabeth, N. J., in *Industrial and Engineering Chemistry*, vol. 22, no. 10, Oct., 1930, pp. 1030–1037, illustrated and accompanied by six tables, *dA*)

PIPE (See also Gas Engineering: Tracy-Crockett Section, Kettleman Hills-Richmond Natural-Gas Pipe Line)

Distribution of Gasoline by Pipe Lines

THIS is one of the newest developments in the oil industry. Several gasoline pipe lines of considerable length have been already built, particularly in the West, for moving natural gasoline from plants to railroad loading stations and also for general distribution. As an example of long-distance natural-gasoline pipe lines may be cited the Shell Oil Company's line from the Ventura field plant to the company's Wilmington refinery at Los Angeles. This line is 97.5 miles long, has a carrying capacity of approximately 3600 bbl. per day, and was built about three years ago at an estimated cost of $1,000,000. The operating pressure of the line is 7000 lb., and the actual losses during the transport are considerably less than 1 per cent.

It is expected that the large increase in the volume of consumption of gasoline will favor the development of this type of pipe line. While the initial investments are very large, the transportation costs are estimated to be but 25 to 35 per cent of those of tank-car shipments. The evaporation losses are also smaller. As regards the initial investment, this difficulty may be met by cooperative ownership as exemplified by the new Great Lakes Pipe Line Company, which is owned by five companies. The factors that are likely to retard development are inability of trunk gasoline lines to transport anything but relatively large batches of each grade or trademark. The estimated minimum varies between 50,000 and 100,000 bbl., which limits the use of pipe lines to the largest producers and distributers. The opposition of various organizations, particularly of railroads, has also to be counted with. Gasoline pipe lines are laid substantially in the same manner as crude-oil lines, but gasoline lines need not consider the freezing-temperature factor, and their capacity is approximately 35 per cent greater than that of a crude-oil line, other factors being equal. Floating-roof elevated surge tanks are used at pumping stations of gasoline lines to keep a pressure of between 6 and 30 lb. per sq. in. on the suction of the pumps, and also to collect any gases or air that may come into stations.

The present tendency is to equip pumping stations with Diesel engines and reciprocating pumps of special design. On the other hand, the Phillips Petroleum Company, which has a large natural-gas supply in the Texas Panhandle, will use gas engines and centrifugal pumps, the gas (butane) being transported through the gasoline line simultaneously with the gasoline. Among the effects which may be anticipated as a result of extensive building of gasoline distributing lines, the following may be mentioned:

Further growth of large, nation-wide producing, distributing, and marketing companies, because smaller companies will not be in a position to compete with well-integrated concerns which have their supply available through a considerably cheaper medium of transport. Increased margin of profit per gallon for companies operating the gasoline trunk lines.

The refineries situated within oil-producing areas reached by trunk gasoline lines will show considerable increase in capacities, more particularly due to installation of additional cracking stills, and in the future the hydrogenation plants

may be built in heavy-oil districts to augment, or even supplant, existing refineries.

The railroads moving motor fuel will show decreased earnings, though such reduction will be very gradual and in some instances may be compensated by other freight, unless the railroads as common carriers participate in pipe-line construction and ownership.

The tank-car leasing companies will apparently lose most, as they are affected directly, and do not have any substitute freight. Union Tank Car Co. and the General American Tank Car Co. are typical tank-car companies leasing cars to oil companies. At this time there are about 275,000 tank cars in operation.

Competition of outlying oil-producing districts may be anticipated in well-established marketing zones. Thus the Mid-Continent gasoline will enter the Chicago, New Orleans, St. Paul, and, possibly, Pittsburgh districts, while Wyoming may successfully compete in the Kansas City and Chicago districts. Such competition may temporarily upset the present balance, but in the long run will tend to stabilize gasoline marketing.

The growth of gasoline lines will provide a considerable amount of business for fuel and pipe-line companies, and incidentally furnish much employment. There may be a possible slight reduction in filling-station quotations in areas entered by trunk lines.

The author considers particularly the situation in Russia and gives a list of existing pipe lines in the United States, together with a map. (Basil B. Zavoico, Consulting Geologist, Tulsa, Okla., in *World Petroleum*, vol. 1, no. 9, Oct., 1930, pp. 443–446, 1 fig., *ps*)

Electrically Welded Steel Pipe

ACCORDING to R. E. Baker, secretary and treasurer of Arthur G. McKee & Co., engineers, who has made a study of pipe lines and factors affecting their efficiencies, the potential pipe-making capacity in the United States is nearly 8,000,000 tons per annum, of which 1,735,000 tons is seamless and 2,200,000 tons electrically welded. Electrically welded pipe has moved from practically nothing to second place in the last three years, while lap-welded pipe has not increased in production.

Until 1927 a line for transmission of gas more than 250 miles was considered an engineering phenomenon. With assured supplies of gas, decreased line-construction cost and suitable pipe for high pressures were needed. This was made possible by the development of electrically welded pipe. Its value lies in greater strength for the same weight and absence of weld weakness, longer lengths making laying cheaper.

Electrically welded pipe 16 in. in diameter to withstand 800 lb. per sq. in. pressure weighs 157 tons per mile less than lap-welded, a saving of about $11,000 per mile for cost of pipe and $2000 per mile in freight charges.

The principal cost of a pipe line is in the pipe, and varies directly as the weight. Increased diameter requires thicker walls for the same pressure, but capacity increases more rapidly than cost, making large-diameter pipe economical. The tendency at present is to increase pressure and deliver gas at high pressure through smaller pipe up to 1500 lb. per sq. in. It is believed that while the construction cost is higher, the cost per cubic foot of gas may be less. Pipe cost is 60 to 70 per cent of the total for 6- to 10-in. lines, about 43 per cent for 10-in. lines, including pumping stations, and 40 to 50 per cent for 24-in. lines. Pipe cost varies with size, while other factors are much the same for all sizes. It is estimated that there will be a probable demand for 15,000,000 to 20,000,000 tons of steel pipe in the next three to five years. (*Steel*, vol. 87, no. 20, Nov. 13, 1930, pp. 25 and 98, 1 fig., *sd*)

POWER-PLANT ENGINEERING (See also Engineering Materials: Materials for High-Pressure Installations; and Steam Engineering: Boiler Horsepower and Ratings)

Power From Tides

IN THE latter part of September, 1930, there was demonstrated at the Avonmouth Dock an experimental tidal power plant worked on a system devised by Paul Shishkoff.

One great difficulty in the utilization of the tides by means of water impounded from the sea in a reservoir, is that for some hours before and after high tide the difference between the level of the water in the reservoir and that of the sea outside does not give sufficient fall to work a turbine.

Under the Shishkoff system this difficulty is met and continuity of supply obtained by the aid of thermal storage. Part of the power produced by the turbine during its working period is used to drive an electrical generator, but part is converted to heat. For the latter purpose a water-friction brake is employed, the water heated by it being stored under pressure in a steam accumulator. When the level of the tide rises too high to permit the turbine to be run, steam is taken from the accumulator and used to drive a turbo-alternator which generates current during the time the water turbine is out of action.

The tidal range at Avonmouth is some 30 ft., and of this about 10 ft. cannot be utilized by the water turbine, which must therefore be idle for about one-third of the tidal cycle. This turbine, which is supplied with water from the dock through a 42-in. pipe line, has a maximum output of about 300 hp., though its actual output of course varies with the state of the tide. Its vertical shaft carries, on the top, a 32-kw. alternator, and lower down, a modified Heenan and Froude hydraulic dynamometer, or brake, which absorbs the surplus power not converted into electricity. The brake is connected with a Ruths steam accumulator having a capacity of about 25,000 lb. of water, and the temperature of this water by circulating through the brake is gradually raised to 380 deg. fahr., corresponding to a steam pressure of 200 lb. per sq. in. In absorbing the varying surplus power the brake also acts as a governor to maintain the speed of the water turbine constant at 500 r.p.m., and thus avoids the expense of a separate governor. When, on account of the rise of the tide the water turbine ceases to be usable, steam is taken from the accumulator to a De Laval turbo-alternator which supplies current until, with the falling tide, the water turbine can again be put into service.

The cost of electrical power under the Shishkoff method of operation has been calculated for many specific cases, and under favorable conditions might, it is claimed, be as low as 0.2d. (0.4 cent) per kw-hr., an average figure for a large installation being one farthing. Applied to the Severn Barrage, the method, its sponsors estimate, would enable power to be generated at 0.2 d. per kw-hr., or about half the cost estimated under the original scheme. (*The Electrician*, vol. 105, no. 2731, Oct. 3, 1930, p. 411, *d*. For a more detailed description of the Shishkoff plant, see *The Engineer*, vol. 150, nos. 3898–99, Sept. 26 and Oct. 3, 1930, pp. 330–332, and 358–360, 15 figs.)

The Suspension Firing of Crushed Coal

IN THE new power plant of the Waterbury Clock Co., Waterbury, Conn., a furnace has been installed in which crushed coal is burned, and is said to have given results of unusual economic interest. The coal is crushed, not pulverized, which means that it is broken up by a hammer crusher so that it will pass through a $^1/_4$-in. screen; as a matter of fact, however, a small percentage of pieces are even larger than $^1/_4$-in. The

coal is delivered to the furnace from a conveyor and slides down by gravity only. In doing this it falls past a stream of air entering horizontally through a slot at a pressure of about 0.4 to 0.6 in. of water. This stream of air assists operation by spreading the coal across the width of the furnace, which has an "inverted pyramid" bottom, the horizontal slot through which air is projected upward and the small grate or "throat" in which the slot is situated being essential to the operation of the furnace. (Fig. 5.) As a result of the converging bottom, air velocity increases rapidly as one goes down. Each grain of coal therefore finds a certain level, depending on its size, density, and shape, where it can float in equilibrium, and the relative areas at the top and bottom are such that, with certain exceptions, practically none of the particles can rise as high as the tube level or fall as low as the slot until combustion is completed. For some reason not yet clear, practically no ash rises as far as the

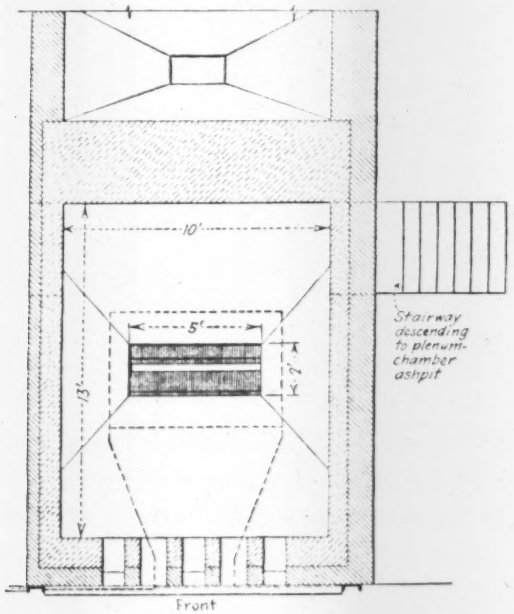

FIG. 5 VERTICAL CROSS-SECTION OF WATERBURY FURNACE SHOWING BOTTOM IN FORM OF INVERTED PYRAMID

tubes, and the average screen size of ash in the pit is considerably larger than that of the coal. Apparently particles of molten ash float around in the turbulent furnace atmosphere, fusing with other particles until the globules are sufficiently large to fall to the grate against the upward air stream.

The grate, it will be seen from the illustration, is in two layers, each divided into two halves. The lower halves do not move in operation except as they are adjusted slightly to control the width of the slot. The upper halves slide slowly back and forth in unison across the lower grate, making about three 4-in. strokes per minute. At each stroke the mixture of coal and ash on one side of the lower grate is pushed over the air jet. Thus the coal particles are blown up into the furnace again, while all ash particles of sufficient size fall through the slot into the ashpit.

F. W. Carter, plant engineer of the company, states from his observation that the kind or quality of the coal has no measurable effect on efficiency or operation. He has tried out eight different coals, varying in volatile content, heating value, ash-fusing temperature, and sulphur content. These ranged from 22 to 37 per cent in volatile, from 6 to 12 per cent in ash, from 2150 to 2640 deg. in fusing point, from 12,960 to 14,480 B.t.u. in heating value, and from 0.8 to 3.4 per cent in sulphur content. All have operated perfectly, and with almost identical efficiencies.

As a result of these tests Mr. Carter is now considering buying coal strictly on a B.t.u. basis without regard to other characteristics. In the Waterbury district the cost per million B.t.u. favors high-volatile coal.

Tests of all of these coals at 100 per cent of rating have shown overall efficiencies of boiler and furnace (without economizer) of between 81 and 82 per cent. The CO_2 ranges from 13 to 15 per cent, averaging about 14 per cent. (*Power*, vol. 72, no. 21, Nov. 18, 1930, pp. 794–797, 8 figs., *d*)

Two-Fluid Cycles for Power Plants

THE author refers in particular to the Emmet mercury-steam cycle at Hartford, Conn., and the device which was described by Dr. E. Koenemann in a paper before the World Power Conference in Berlin. The process devised by the latter requires the boiler to contain a mixture of the simple and double ammoniates of zinc chloride instead of water. These substances $ZnCl_2NH_2$ and $ZnCl_22(NH_3)$, are fed into a boiler through a heat exchanger, in which they are raised to a temperature of 426 deg. cent. The boiler works at 480 deg. cent., at which temperature the substances are partly decomposed and ammonia is driven off at a pressure of about 100 lb. per sq. in. abs. The ammonia vapor is used to drive a turbine, from which it exhausts at about 1 lb. abs. pressure and 115 deg. cent. temperature into an apparatus like a jet condenser. Here it is not condensed, in the engineering sense, but reabsorbed by the injection liquid which has the same composition as the boiler liquid, and, being much cooler, is able and anxious to take up ammonia again and revert to its original constitution. The inapplicability of the word "condenser" to describe the apparatus will be evident from the fact that the injection liquid enters it at 219 deg. cent., or 104 deg. cent. hotter than the vapor to be "condensed." Part of the contents of the absorbing apparatus is pumped back to the boiler through the heat exchanger, and the excess, together with the hot liquid from the boiler which heats the exchanger, is circulated through the tubes of a steam generator, after which it serves again as injection liquid for the absorber. The steam generator supplies ordinary steam at about 300 lb. pressure for the low-temperature part of the cycle, which follows ordinary steam practice.

Such, in outline, is a particular case of the Koenemann process. The inventor anticipates that the superposition of this ammonia cycle on an ordinary cycle using steam at 300 lb. pressure, will result in a saving of 29.5 per cent of fuel and a reduction of 41 per cent in the amount of cooling water required. An overall thermal efficiency from fuel to shaft horsepower of 32.4 per cent would be realized according to the calculations given, and even this figure would be improved on with a higher steam pressure for the second portion of the cycle. The chemicals, moreover, are cheap and non-corrosive, and there is no reason why the plant should be expensive in first cost. Under experimental conditions, the ammonia salts have given no trouble, the boiler pipe work and pump metal being unattacked by them. Nor has there been any difficulty with leakage at the flanges. The design of effective turbine glands to prevent the escape of ammonia vapor, and stuffing boxes on the pumps to retain hot ammoniates, are obviously matters incidental to the proper functioning of a plant on the lines proposed by Dr. Koenemann, but a lot can be done with the incentive of an overall thermodynamic efficiency of well over 30 per cent. The realization of such efficiencies with turbine machinery and boilers would still further weaken the position of the internal-combustion engine, hard pressed as it now is by steam, and relegate to some unknown future the day so often confidently predicted when

explosion engines will be the universal source of thermal power. (Editorial in *The Engineer*, vol. 150, no. 3902, Oct. 24, 1930, pp. 458, *dc*)

SPECIAL MECHANISMS

An Infinitely Variable-Speed Drive

THIS drive employs a friction gear of the differential type, and its action depends on the rolling of hardened and ground rollers on hardened surfaces. By varying the mutual points of contact a uniform speed variation under constant load can be obtained within certain limits.

The four main elements (see Fig. 6) comprise the rollers or balls 4, roiling within three co-axial circular paths, of which 1 is the driving path, 2 the driven path, and 3 the fixed path. By altering one of these four parts a displacement of the points of contact may be effected, resulting in an increase or diminution of the rolling paths, with consequent speed variations. From Fig. 6 it will be seen that according to the direction in which the axis *y-y* of the balls is set, path 3 becomes larger or smaller than path 2, with the result that the element forming path 2 turns either in the same or the opposite sense to 1.

The important feature of the gear is the device used for producing the necessary pressure at the points of contact. This contact pressure is produced by the wedge action of two oblique or spiral surfaces between which ball bearings are inserted to obtain maximum sensitivity. It is claimed that the gear shows an efficiency of more than 90 per cent over the greater part of the working range. The original article shows efficiency diagrams at constant and variable speed, and photographs of the gear assembled and disassembled. As an example is cited a drive for a disk turning lathe, in which the elimination of stepped gearing permits a smooth and even finish to be secured at any diameter of the disk. Another example is the driving of a paper machine where several drives running at various relative speeds are required. Previous to the introduction of the variable drive here described the Ward Leonard has been used, and the original article gives a comparison of the relative efficiencies of the two. In one of the drives described in the article the introduction of a spur-gear differential makes a ratio of 10,000 to 1 possible in one stage. The gear is made by Escher-Wyss and Company in Switzerland. (A. Page in *Mechanical World and Engineering Record*, vol. 88, no. 2272, July 18, 1930, pp 56–59, 13 figs., *d*)

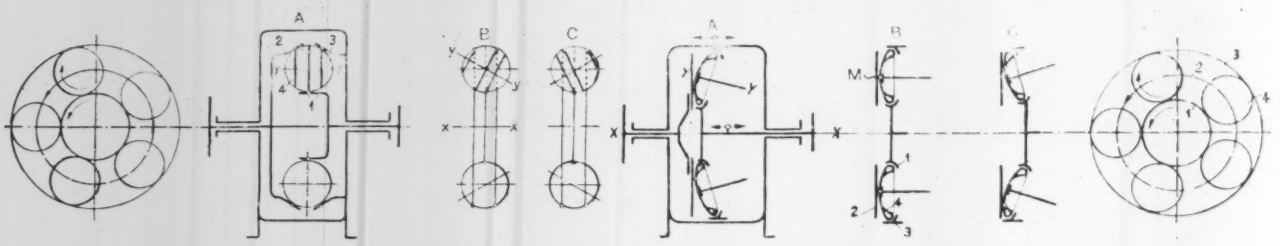

Fig. 6 The Escher-Wyss Infinitely-Variable-Speed Drive

STEAM ENGINEERING

Boiler Horsepower and Ratings

IN A REVIEW of recent boiler practice in New England, the author incidentally refers to the terms "boiler horsepower" and "per cent of rating."

The 1400-lb. boilers at the Edison Edgar station gives a good illustration of the inadequacy of these terms to describe the performance of modern steam generators. These boilers each have a designed output of 250,000 lb. per hr., the boiler heating surface is 6973 sq. ft., and the water-wall surface 1200 sq. ft. The heat added to the steam is 1185 B.t.u. above a feed temperature of 220 deg. The evaporation from and at 212 deg. is therefore about 305,000 lb., corresponding to a "rating" of 1275 per cent based on boiler heating surface, and 1090 per cent based on boiler and furnace surface.

The practice of operating boilers at ratings in excess of the original 10 sq. ft. per hp. first found general application about 16 years ago. The high ratings of those days were 175 per cent or at most 200 per cent of normal, the limitation being the furnace refractories and the size of the stoker. Development of large stokers and of pulverizers, together with the introduction of cooling elements to protect refractory material, has permitted much further progress. In tables given in the original article there are seventeen stations listed which are designed for operation at 300 per cent of rating or higher. Most of these high-rating stations are either utility plants or paper mills, the high load factor of the latter usually justifying the expense of the high-rating design.

From the same article it would appear that pulverized coal is evidently rapidly forging to the front, showing as it does a total of 22,200 new hp. capacity against 33,900 for stokers and 15,960 for oil. The two plants having the largest boilers of any in the list are pulverized-coal units. Unit mills are used practically everywhere.

All of the pulverized-coal plants have some form of furnace cooling, either air-cooled walls or water walls. In the oil plants there are seven with air- or water-cooled walls and five with solid walls. In the stoker plants the water-cooled bridge wall occurs in eleven cases out of twenty-two, sometimes in connection with more complete cooling and in other cases as the only cooling feature. Several of the stoker plants noted on the list as having solid walls have silicon carbide ventilated block refractories above the stoker line in side walls and bridge wall. (D. D. Eames, with Lockwood, Greene, Engrs., Inc., Boston, Mass., in *Power*, vol. 72, no. 20, Nov. 11, 1930, pp. 755-757, 4 tables, 2 figs., *cA*)

TRANSPORTATION (See Pipe: Distribution of Gasoline by Pipe Lines)

WELDING (See Pipe)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Engineering and Industrial Standardization

New Safety Code for Mechanical Refrigeration

A NATIONAL safety code for mechanical refrigerators of all types, both domestic and commercial, has just been approved by the American Standards Association. Refrigerating apparatus used in the manufacture and processing of materials such as in ice-making plants, cold-storage warehouses, ice-cream and dairy plants, packing houses, and chemical plants, and also cooling systems of theaters, and other buildings are covered in the provisions of the code, which was prepared by a technical committee organized under the procedure of A.S.A. with the American Society of Refrigerating Engineers as sponsor. Commercial plants of the type used in meat markets, florist shops, and restaurants are also covered.

One of the most important provisions of the code, which permits the installation of multiple systems in apartment houses with adequate safeguards to eliminate possible hazards, ends a long-standing controversy on this question. This will probably mean that regulations prohibiting the installation of multiple systems such as exist in New York City and other municipalities will not become an important factor in the refrigeration industry.

Forty-three national organizations were represented on the technical committee, which has been at work since 1920.

The code applies to both direct methods of refrigeration, in which the refrigerant is circulated through the system, and to the indirect, in which brine or water cooled by the refrigerant is circulated through the system.

The code provides that industrial systems using the direct method of refrigeration may, subject to certain provisions, be located in separate buildings or separate sections of buildings; regulations giving the location of commercial systems using the direct method of refrigeration are also given.

Several sections of the code are devoted to safety devices which must be provided in all types of refrigerating apparatus. The code provides that in apartment-house systems "any refrigerant, the vapors of which are harmful to health and which are not readily apparent to a human sense, shall have added thereto a substance to make its vapors readily detectable."

Copies of the code may be purchased from the American Standards Association, 29 West 39th Street, New York, N. Y. at 30 cents per copy.

Standards for Gas Appliances

A NEW project for the establishment of American Standards for the basic requirements of gas appliances has just been announced by the American Standards Association. The project will be placed in the hands of a technical committee under A.S.A. procedure at the request of the American Gas Association, which will direct its work.

The scope of the work as agreed upon by the A.S.A. and A.G.A. is the "establishment of minimum requirements for performance, safe operation, and substantial and durable construction for domestic gas-burning appliances; together with laboratory methods of test for determining compliance therewith."

A committee of the A.G.A. has been working on this subject for a number of years. This committee, enlarged to assure balanced representation of producers, distributers, consumers, and other important groups, will now continue this work under A.S.A. auspices. Acting under the chairmanship of R. B. Harper, Peoples Gas Light and Coke Co., Chicago, Ill., the committee will include representatives of: U.S. Bureau of Standards, U.S. Bureau of Mines, U.S. Department of Agriculture, U.S. Public Health Service, U.S Bureau of Home Economics, American Home Economics Association, Master Plumbers' Association, Heating and Piping Contractors National Association, five individual gas companies, and seven individual gas-appliance manufacturers.

Important Addition to A.S.A. Membership

THE formation of a Light Metals Group, with the Aluminum Company of America as the first member of the group, is announced by the American Standards Association. This group becomes the forty-fifth member-body of the Association with representation on the Standards Council. The latter now includes organizations of national scope representing a large proportion of the major branches of the manufacturing, mining, and public-utility industries, national engineering societies, safety and insurance groups, and several departments of the Federal Government. It is expected that the creation of the light-metals group will greatly stimulate the establishment of national standards and specifications covering the processes and products of the light-metals industry, which include aluminum and magnesium, their alloys, and alloys of these metals with other metals.

Advantages of Uniform Safety Regulations

AT LEAST one thousand deaths, 125,000 injuries, and a money loss of $40,000,000 is the annual toll exacted because of needless disagreements in the industrial safety regulations of the various states. This statement was made by Cyril Ainsworth, safety engineer of the American Standards Association in an address before a joint meeting of the Safety Engineers' Club of Baltimore and the Baltimore Section of the A.S.M.E.

The states which prepare their own local safety regulations, instead of agreeing on national safety codes, place an obstacle in the way of effective guarding of industrial machines by manufacturers of the machines, Mr. Ainsworth declared. Their

NEW AMERICAN STANDARDS

The following standards were approved by the A.S.A. during the month of November 15–December 15, 1930:

Track Bolts and Nuts, (B 18d). (American Standard.)

Sponsored by the Society of Automotive Engineers and The American Society of Mechanical Engineers. Published by the A.S.M.E.

Ultimate Fiber Stresses of Wood Poles, (O 5a). (American Standard.)

Sponsored by the Telephone Group. Published by the Telephone Group.

adherence to national industrial safety codes, he said, would inevitably be followed by better mechanical guarding of hazardous machines and a substantial reduction in the yearly industrial accident toll, which at present amounts to 25,000 deaths, 3,000,000 injuries, and approximately $1,000,000,000 in money loss to workers and employers.

Responsibility can be definitely placed on the states because the machine-tool industry has declared itself "ready and willing to do all that it can toward the equipping of machines with adequate guards at the point of manufacture as soon as there is brought about some degree of harmony in existing regulations.

"Such a statement is a definite challenge to the entire accident prevention movement and to all those associated in any way with the movement. There are many indications that the challenge is being accepted and met. The action taken by the Industrial Commission of Maryland in adopting, verbatim, twenty national safety standards; that taken by Nebraska in basing its recently adopted standards on the national standards; that taken by such states as Pennsylvania, New Jersey, New York, Ohio, California, and several others in basing their regulations on the national standards and adopting many standards without change, are concrete evidences of progress that is being made. In addition, many states, including Virginia, West Virginia, Maine, Tennessee, and Idaho, have appointed commissions to consider the necessity and desirability of passing legislation that will permit the adoption of national safety regulations."

A.S.M.E. Boiler Code Committee Work

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretations of the Committee in Cases Nos. 663, 664, 666 to 669, inclusive, as formulated at the meeting on October 24, 1930, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 663

Inquiry: *a* Could not Par. P-261 of the Code be arranged to provide for the corrosion allowance to be subtracted from the actual shell thickness when using the formula in the case of vessels with extra shell thickness?

b Could not a paragraph be inserted in the Code permitting the replacement area to be calculated in accordance with section *a* of Par. P-261 when the area computed according to section *b* is larger?

Reply: *a* In case a shell is made thicker than called for by the Code formula in order to allow for corrosion, the rules in Par. P-261 shall be based on the thickness of the shell plate less the amount added for corrosion.

b The required strength of the rivets in shear in the flange of a nozzle may be computed by both sections *a* and *b* of Par. P-261, and the lesser of the two values used.

CASE NO. 664

Inquiry: Is it necessary, in inserting minus dished heads (convex side to pressure) in the shells of pressure vessels, to reduce the thickness of the head flange as required by Par. U-75 of the Code, by turning it in the lathe as shown in Fig U-3$^1/_2B$, or may this reduction be made by chipping or grinding?

Reply: The Code is not mandatory in its requirement for reduction of thickness of head flanges to the exact form shown in illustrations in Fig. U-3$^1/_2$. It is the opinion of the Committee that if the edge of the head flange at the point of weld is reduced to approximately the same thickness as the shell by either chipping or grinding, the intent of this requirement will be met. In case of such chipping or grinding, it is merely necessary to effect the reduction within the distance $1^1/_2T$. It is the opinion of the Committee that a variation of thickness between the edge of the head and the shell plate of 20 per cent of the shell-plate thickness should be construed as complying with the Code requirements provided the head is of the thickness required by the Code.

CASE NO. 666

(In the hands of the Committee)

CASE NO. 667

Inquiry: Is it the intent of the Code that the reference in section *a* of Par. P-261, which requires double riveting for manhole frames on drums 48 in. or larger, shall apply on nozzles which may be used as nozzles or manholes?

Reply: The Committee points out that if the rules given in Par. P-268 for attachment of nozzles are met with a single row of rivets, a double row is not required.

CASE NO. 668

Inquiry: Will the thermit pressure method of welding be considered under the rules of the Code as the equivalent of the forge or hammer welding process for welding together ends of pipe or tubing, where the thermit reaction is utilized only for heating up the ends prior to pressing them together as is done in the pressure electric-welding method?

Reply: If the application of the thermit is solely for the purpose of heating the surfaces to be joined and no extraneous metal is added at the joint, it is the opinion of the Committee that the method may be considered as the equivalent of the forge welding process.

CASE NO. 669

Inquiry: Is it to be understood from the revision of Par. H-74 of the Code, that the use of the regular flange and firebox classes of boiler-plate steel are no longer permitted for the construction of low-pressure steel heating boilers?

Reply: In revising Par. H-74 to eliminate the carbon limit, the provisions for flange and firebox steel of the type given in the specifications in Pars. S-5 to S-17 were inadvertently omitted, as well as the provision for the use of steel of a lower tensile strength. It is therefore proposed to add the following to Par. H-74:

> "or of Pars. S-5 to S-17 of Section II of the Code. If desired, steel of lower tensile strength than specified may be used, the desired tensile limits to be specified with a range of 10,000 lb. per sq. in."

Correspondence

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

Early Hydraulic-Turbine History

TO THE EDITOR:

It has just been brought to my notice that the statement "the Holyoke testing flume has since passed into history" which appears in MECHANICAL ENGINEERING of April, 1930, in the article under my name is erroneous. I shall be obliged, therefore, if you will have the record set right, so that engineers may know the facts regarding that historic and important testing flume.

Evidently the late Clemens Herschel, to whom I submitted the draft of my paper, also labored under the impression that the testing flume was no longer in use, and I am sure were he living he would be as prompt as I in acknowledging the mistake.

For your information I am enclosing a copy of a letter from the Assistant Hydraulic Engineer of the Holyoke Water Power Company, Mr. A. W. Ladd, on the subject.

EDWARD DEAN ADAMS.[1]

New York, N. Y.

[The substance of Mr. Ladd's letter to Dr. Adams is given below.—EDITOR.]

. . . . At the present time the Holyoke testing flume is fully equipped for test purposes and is open to any one desiring to make tests of a hydraulic nature on such apparatus as water wheels, flow meters, pipes, or pumps.

The present testing flume has been in existence nearly fifty years, and during the first twenty-five years 1515 tests were made upon water wheels and 1621 during the last twenty-five years. During the ten-year period beginning in 1910, there were over 800 tests made, which was the greatest number in any like period.

In recent years, several of the larger water-wheel manufacturers have built testing flumes of their own, resulting, to some extent, in less testing at the Holyoke flume. However, the capacities of these flumes are relatively small, and the advantages of testing under the maximum conditions of discharge are still quite frequently found desirable.

Production of Plastic Molded Telephone Parts

TO THE EDITOR:

Referring to the paper[2] by A. M. Lynn on the above-mentioned subject, the Delco-Remy Corporation has two phenol plastic molding departments with a total of 88 hydraulic presses ranging from 30 to 150 tons in capacity. Of this number 65 are of the semi-automatic type with automatic press-operating and timing controls. These departments have a capacity of several hundred thousand parts per day, ranging in size from the tiny insulating bushing used on a wiring harness, to the 5-in. distributer cap used on a Cadillac distributer.

This company uses a two-pressure hydraulic system with a high pressure of 2300 lb. and a low pressure of 550 lb. These pressures are maintained by high-pressure pumps and the weighted type of accumulators. In its case there are two main objects in having a two-pressure system. The first and most important is to close the mold on the charge at a relatively low pressure, giving the resin a chance to soften and flow without forcing the inserts out of place, as would be the case if the high pressure were applied suddenly and directly. The second object is the saving of high-pressure water in closing the gap between the mold halves.

The closing and opening of the molds and the application of the high and low pressures are handled entirely by automatic controls. For illustration, let us take the molding of a coil top, which is a typical high-production part, containing 5 inserts. This is molded on a 150-ton press in a 16-cavity mold. After the operator has loaded the mold with the inserts and Bakelite preforms, he turns the button starting the automatic control. He can then engage in other work until the press cycle is complete. The press will close at the proper speed on low pressure. It will hold the molds closed on low pressure for approximately 20 sec. and then the high pressure is applied and held for $2^1/_2$ min., after which the press opens. The operator can remove the finished pieces and reload the mold in about 45 sec., making a total floor-to-floor time of less than 4 min., and giving a production of 15 parts per hour per cavity, or 240 parts per hour per mold.

Both the top and bottom platens of the presses are fitted with ejector mechanisms. These ejectors are operated hydraulically, entirely independently of each other and of the action of the main ram, which gives a very flexible operation of the ejector pins. For example, in the case of the coil top previously mentioned, the operator by turning the pressure on the bottom ejector before the press is opened, can cause all of the parts to remain with and stick to the upper half of the mold as the mold opens. From there they can be ejected into a pan, and laid on the bottom half of the mold by the operation of the top ejector. Inserts which must project into both halves of the mold can also be very conveniently handled by means of this mechanism. This is accomplished by placing the inserts into the cavities in the bottom half of the mold and having the ejector pins projecting down through the holes into which the inserts must go as the mold is closed. As the mold is closed the ejector pins make contact with the inserts and then are permitted to recede so that the inserts will follow the ejector pins into the holes, the pins preventing the plastic material from flowing into the holes before the insert enters. By putting centers into the ejector pins and using the method outlined above, they can be made to help hold inserts in place against the flow of the plastic material while the mold is closing. Hollow inserts such as threaded bushings can also be molded into place without the center cavity being filled, by trapping the insert with the extended ejector pins and permitting the pins to recede as the mold is closed. The inserts and Bakelite preforms are loaded into the molds by means of loaders which are preloaded on the bench in front of the press during the molding time.

The company uses no tilting-head presses and the writer does not believe that they would be of any great advantage on any of the parts now manufactured. He can readily see that they might be of some advantage on the hand-set telephone parts, on any part requiring a number of loose pieces in the mold or having complicated inserts which could not be placed in the mold readily with a loader, or in the case of the Duo tilting-head presses, a part requiring cooling in the mold. The company has no parts which require cooling in the mold and, consequently, never has cooling water running through the steam plates. All pieces are removed hot, and in a few cases where it is desired to hold accurate sizes and shapes such as on distributer caps, the pieces are cooled on a water-cooled fixture.

Mr. Lynn mentiones the use of low-shrinkage oil-hardening manganese steel on the hand-set-telephone part molds. The

[1] Engineer-Financier.

[2] MECHANICAL ENGINEERING, October, 1930, p. 889.

writer's company has tried such steels in molds, but its experience has been that these molds crack very easily after a comparatively short run.

The best success has been obtained with plain carbon tool steel which is oil hardened without draw, or in the case of molds which it is desired to shape by the hubbing process, from Armco iron which is carburized and hardened after the hubbing and machining operations.

LEO C. SHIPPY.[3]

Anderson, Ind.

TO THE EDITOR:

With reference to the discussion of Messrs. Lynn and Shippy on the desirability of using the two-pressure hydraulic system in phenol resinoid molding, experience has pointed out that such an arrangement is of considerable value. It makes the molding operations more foolproof, and therefore in the long run is more economical.

As an illustration, let us consider an automatic-press set-up where a quarter of a pound of molding powder is required per cavity, as is the case with some of the parts discussed. Assume only high pressure, from 2000 to 3000 lb. per sq. in., is available. If the press is closed immediately after placing the molding material into the cavity, the result is that such a mass of powder does not have time to take up enough heat from the mold to become plastic while maximum pressure is being applied, and therefore instead of being molded in the true sense of the word, it is compacted by direct physical force under the tremendous pressure. There is little give or flow in the molding material in that non-plastic or partially non-plastic state, and therefore if the mold contains some small steel pins or metal inserts, they are quite likely to be sheared off or otherwise damaged, as is borne out by the experience of Mr. Shippy. Also it has been found in most cases that strength in the piece, finally hardened by polymerization under the heat and pressure, has been sacrificed under such production conditions.

Using the two-pressure system the mold is first closed under low pressure, say, from 200 to 400 lb. per sq. in. The molding powder is then compressed, without doing damage to mold pins or inserts, until its resistance equals the applied pressure. Here the travel of the ram halts for a number of seconds depending upon the size of the charge, until sufficient heat has been absorbed by the compacted powder to make it soft and plastic. The press ram will then start moving again. If at about that time the high pressure is applied, the molding powder, now a plastic, will flow and compress, probably with a kneading action, to give a uniform, homogeneous section throughout the piece, and therefore greater strength.

It is possible, where only high pressure is available, to control the closing of the mold by careful hand manipulation of the valve so that the desired results are obtained, but this is hard on the valve, and to a much greater extent brings into the picture the human element, with possibilities of error and rejections. Also, allowing the powder to lie in the hot mold cavity for a short period of time before applying the high pressure directly, helps as far as filling out or forming of the piece is concerned, but due to excessive heating of the loose powder contacting with the hot mold, it is done at the expense of finish.

Years ago the two-pressure system was absolutely indispensable. Today the phenol resinoid molding materials have been so highly developed that many grades will soften very rapidly, when heated, and therefore small pieces requiring but a comparatively small charge of powder can safely be molded with only high pressure. However, where a substantial mass of powder is used per cavity, the two-pressure system unquestionably provides the best guarantee of good molding.

R. A. BRENNECK.[4]

Chicago, Ill.

TO THE EDITOR:

I have noted Mr. Shippy's comments and his description of the Delco-Remy methods of molding phenol plastic automotive parts and also Mr. Brenneck's discussion of the two-pressure system in plastic molding. The question of using a single-pressure or two-pressure hydraulic system seems to me to be largely a matter to be decided by a comparative analysis of the installation and maintenance costs of the two systems. Where it is known that much of the output will consist of parts containing inserts which are likely to be damaged in molding and where installation and maintenance costs are reasonably low, the use of the two-pressure system can possibly be justified. In our production of plastic molded telephone parts, we have only a single part, namely, the handset telephone handle, in which the distortion of inserts during molding is a factor. This part is, however, produced with a molding cycle which allows a warming period for the powder, and we have therefore not encountered any serious difficulty with distortion of inserts.

It seems to me that most of the advantages of a two-pressure system in so far as it permits the compound to be softened before the final pressure is applied, can be obtained by the use of a preheating oven for warming the compound prior to charging the mold. This equipment with a single-pressure system, I believe, would be cheaper in first cost and operation than a two-pressure system wherein the press itself is used as a preheating means, although relative costs will of course depend on many varying factors.

The use of automatic valve-operating gear I personally believe to be an excellent idea if such a mechanism can be installed at a reasonable cost. The use of such devices should result in an increased output and greater uniformity in the molding cycle than is ordinarily obtained by hand operation.

The use of tilting-head presses I believe can be justified on production jobs in which multiple-cavity molds containing a number of mold details—all of which must be properly located to avoid injury to either the punch, the detail, or the cavity—are used. In the molding of telephone parts we have a large number of molds containing 30 to 50 cavities each, which require the accurate seating of every mold detail in every cavity to avoid injury to the mold. As the mold-cavity parts and details are made of hardened tool steel ground to close dimensions and highly polished, the investment in molds is rather high, and the use of tilting-head presses as an insurance against accidental damage to molds by reason of a misplaced detail is, we believe, justified.

Our use of low-shrinkage oil-hardened manganese steel for mold parts has, in general, been satisfactory when heat treated by the methods described. We feel that this steel is better for our purpose than an ordinary tool steel because of the close dimensional limits imposed on many of our molded parts and the fact that a number of our heavy running molded parts contain molded threads on which the tolerances are close.

A. M. LYNN.[5]

Chicago, Ill.

Ira Nelson Hollis

TO THE EDITOR:

Among the thousands of boys who sat before Professor Hollis' desk during his 20 years at Harvard, or who received their di-

[3] Delco-Remy Corporation.

[4] District Manager, Bakelite Corp.

[5] Mechanical Engineer, Western Electric Co.

plomas from his hands as president of the Worcester Polytechnic Institute, very few had the exceptional fortune to know him as I have, not only in the classroom and office, but also in his home. Thus, as one of the number of engineers who are carrying on their professional careers with the stamp of his influence, I can see many characteristics which should be remembered and written into the permanent records of the Society. Of these, two stand out most clearly in my mind.

In the first place, Dr. Hollis was a teacher in the highest sense of the word and to him education meant the drawing out of one's best potentialities. He emphasized his lessons, most of which were not in a book, by a nod of approval or a stern rebuke, sometimes made more emphatic by a powerful blow on the desk; but regardless of whether he expressed approval or disapproval, there was behind it always a kindly and sincere interest in the boy.

Through his devotion to the best interests of younger men, Dr. Hollis regarded each student as an individual, different in some respects from all others. To each and every one with whom he came in contact he gave himself wholeheartedly, regardless of whether the student were about to graduate with high honors, or to leave for other reasons.

Dr. Hollis had great sympathy for the unfortunate, and I have heard him, years afterward, express his regret that a certain freshman who had left on account of financial reasons, had not spoken to him of his need before dropping out. During the very busy period at the end of the school year, he took the time to call, personally, on the father and mother of one of the boys, in order that he might explain to their satisfaction why it was that their son's diploma would have to be withheld for a year.

The second quality so characteristic of Dr. Hollis was his ability to see, in spite of present failure, the possibilities of eventual success. He was called upon, often under unpleasant circumstances, to induce men to change the course of their lives for the sake of reaching the path which would lead them to success. Frequently such a change would be difficult, but with the vision of the future, he would follow the dictates of his best judgment. I know that I am not alone as one who was encouraged to start afresh on a new line after an experience which seemed most unfortunate at the time.

CARROLL F. MERRIAM.[6]

Baltimore, Md.

Future Aircraft-Design Trends

TO THE EDITOR:

In his paper, "Future Aircraft-Design Trends," in the November, 1930, issue of MECHANICAL ENGINEERING, the author, Mr. Robert R. Osborn, has given some very sound advice to aircraft executives. Safety is the paramount requirement of the future development of civil aviation. Everything is contingent upon it. The manufacturer will probably never have mass production—at least in this country—until airplanes can be purchased on a sound and liberal time-payment basis. On the other hand, any successful time-payment plan depends upon greatly decreased insurance rates, and, of course, the latter depend primarily upon safety.

In the final analysis the present price of the airplane must greatly decrease with increased safety. Aside, then, from the humanitarian aspect, safety is essential to economic success in this whole aviation business.

With the simple and logical improvements suggested by Mr. Osborn for increasing speed range, controllability, and the general safety characteristics of airplanes, it is astonishing that so many engineers have adopted the attitude of the ostrich, burying their heads in the sand. Pilots, too, are greatly at fault. During the recent tour of a prominent exhibition team, which displayed, among other things, the winning Guggenheim safety contest airplane, one was astonished to hear the events announcer (who also is a famous pilot) inform the crowd that the only thing unsafe about most airplanes was the propeller, which might be absentmindedly walked into!

When Mr. Osborn states that it would have been impossible for any airplane of conventional type to have even qualified for the Guggenheim safety competition, he states a truth which has not generally been appreciated by airplane designers. It was the writer's good fortune, with Mr. Osborn, to have had the opportunity of carrying out a complete analysis of the possibilities of winning that contest with various types of aerodynamic arrangements, including a structurally light airplane without wing slots, flops, or floating ailerons.

Our studies confirmed the opinions of Prof. Alexander Klemin and others of the Guggenheim Fund, who had already concluded that the contest requirements probably would not be met by any airplane without auxiliary devices for the improvement of speed range and control beyond the critical angle of attack of the wing.

The antipathy of aeronautical engineers in general toward the adoption of aerodynamically satisfactory devices for increasing the lift of wing cellules has been largely due to many failures in the past to adopt these feasible improvements with material success. The failures in most instances have been the result of improper aerodynamic design. Contrary to general thought, the wing area must be increased rather than decreased with slots and flaps to give an all-around improvement in airplane performance and control. The additional wing area compensates for increased weight in order to maintain the desired rate of climb, and the wing section is changed to one of more nearly symmetrical form (with slots closed and flaps neutral) to prevent loss in top speed with increased area. A resulting slow landing speed is obtained by increasing the camber of the wings with flaps and controlling the rate of burbling by means of slots. Since a slotted airfoil is susceptible to autorotation at its critical angle, it is necessary to provide a means of lateral control such as the floating aileron independent of the wing in order to maintain sufficient lateral control at the stalling attitude.

Mr. Osborn is to be commended not only for his material accomplishments in regard to improved airplane safety, but also for his untiring efforts to awaken the interest of the industry in safety from the standpoint of dollars and cents—as well as from the more important viewpoint of the loss of life through scores of accidents unjustly attributed to errors in piloting but actually caused by inherent defects in the aerodynamic design of conventional airplanes.

WILLIAM H. MILLER.[7]

Baltimore, Md.

THE earth is in motion at a terrific speed. It is charging through space, with the rest of the solar system, at the rate of 750 miles a minute; it is also traveling along its orbit around the sun more than 1000 miles a minute; and its rotation around its axis gives any place on the equator an additional movement of more than 1000 miles an hour. The fact that the earth holds together in spite of such movements shows that it is strongly constructed; but it is sufficiently plastic, owing to its hot interior, to be automatically molded into a spheroidal form.—Prof. J. W. Gregory in a lecture on "The Machinery of the Earth," before the Institution of Mechanical Engineers, London, Nov. 7, 1930.

[6] Pennsylvania Water & Power Co. Mem. A.S.M.E.

[7] Assistant Chief Engineer, Berliner-Joyce Aircraft Corporation. Mem. A.S.M.E.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

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BY-LAW: The Society shall not be responsible for statements or opinions advanced in papers or . . . . printed in its publications (B2, Par. 3).

Larger Type

BEGINNING with this issue of MECHANICAL ENGINEERING, a larger size of type will be used in the text pages which precede the departmental sections. Because the Progress Reports of the Professional Divisions constitute practically the entire January issue, the new type is used this month for only one article. Hereafter every article which appears ahead of the "Survey of Engineering Progress" will be set in the larger type.

Fifty Years of Engineering Service

ENGINEERS in the industrial district of which Pittsburgh is the center have been fortunate during the past fifty years in the services which the Engineers' Society of Western Pennsylvania has rendered them. Visitors who have been privileged to make use of the society's rooms in Pittsburgh, have come away with a warm regard for the cordial spirit of the organization. Location in a district where engineering has made spectacular advances has given a sturdy purpose to the society and has enlarged its opportunity to be of real help to its members. The society, its officers, and its members are to be congratulated on this occasion for the fifty years of engineering service just completed.

Members of the national engineering societies in the Pittsburgh district look to the Engineers' Society of Western Pennsylvania to coordinate their local activities; thus a close relationship exists between the national and regional groups. At the anniversary exercises, Julian Kennedy, gold medalist and member of the A.S.M.E., spoke as representative of the field of mechanical engineering. Other members of the A.S.M.E. representing other branches were Charles F. Scott, who spoke for electrical engineering, and Morris Knowles, who, on behalf of civil engineering, gave an inspiring address on the obligations and responsibilities of engineers to the community. The professional interests of engineers are well served by cooperation among engineering organizations.

Making a Complete Job of It

IT IS HARD to commend too highly the address which Prof. Elliott Dunlap Smith delivered at the A.S.M.E. Annual Dinner, the written version of which forms our leading article this month. This challenge to engineers to assume full responsibility for the obligations which the revolutionary effects their machines have on the lives of all men, and particularly upon those who labor among the machines, has been stated in other words in this journal many times. Professor Smith has driven home his challenge with a graphic illustration of the effects of complete and incomplete solutions of the problem that presents itself when engineering encounters human nature.

The Alloys of Iron Research

THIS important project is under the general auspices of the Engineering Foundation, with direct cooperation by the Founder Societies, other engineering bodies, engineering schools, and industrial concerns. The work done so far consists of a study of the combinations of iron with silicon, a research on the combinations of iron and manganese, and a critical review of the metallurgical literature in the broad meaning of the term. This latter is to cover a list of approximately 2000 publications in ten languages, as well as books. Up to the end of last August, 695 technical articles had been reviewed and 2384 abstracts made.

A form for use by abstractors has been printed on durable paper. Designed to expedite abstracting, it can also be filed and cross-indexed for quick reference. Thus all the information gathered on any one or several subjects can be readily assembled for use by the Committee or others, now or at any future time. As the review of literature progresses there is being speedily built up a valuable body of reference material on which may be based later a service of great convenience to persons preparing programs for research, patent claims, and papers for technical societies, as well as for other purposes. From this file bibliographies on many subjects may readily be compiled. A self-indexing filing system has been put into operation.

The Iron Alloys Committee will strive also to avoid entanglements with patents in commercial ways. Such laboratory research as the Committee may undertake or foster will be directed toward the determination of basic data that may be freely made known. Utilization of these data to devise or develop commercial processes, alloys, or equipment will be left to the industries.

The minimum fund estimated to be necessary for five years' work on the review of metallurgical literature is $150,000, of which a sufficient share has already been raised to begin this activity.

The "Iron Age"

THE *Iron Age* has commemorated its 75th birthday anniversary by issuing a special number of great interest to engineers and industrialists who find in the review of the past three-quarters of a century an opportunity to evaluate the progress that has been made and a vision of what is yet to be.

The Anniversary issue of November 20, 1930, begins with a

survey of the industrial background of 1855 by Joseph W. Roe, authority on the history of the machine-tool industry. A number of interesting review articles by well-known authorities follow, and excerpts from previous issues of the *Iron Age* add interest. It comes as quite a shock to younger men that as many of the subjects that are actively discussed today and so many machines and processes that are talked of as being new were brought to the attention of engineers through the columns of the *Iron Age* many years ago.

A. I. Findley's review of the history of the *Iron Age* shows how the paper grew to become such an important and constructive factor in the metal industries because of its market reports, statistics, and economic viewpoint, as well as its publication of the news and technological features of the field it covered. For the esteem in which the *Iron Age* is held because of these features, Mr. Findley himself deserves a major portion of the credit. In the history of the paper which he edited so ably for a quarter of a century, Mr. Findley sees the tendency of industry to follow the course the *Iron Age* has pointed out when he says that "for the next decade all signs indicate that progress on the distribution problems of the industry will be for the first time comparable with the mechanical and metallurgical advance in steel production."

Mr. Macon and his associates who were responsible for the excellent and instructive anniversary issue of the *Iron Age* promise to maintain the position that their paper holds by virtue of its past achievements and to continue leadership in the constructive service it has rendered to the metal industries for the past seventy-five years.

High-Temperature Metals

IT IS THE development of high-temperature metals, which today means in particular nickel-chromium and chrome-nickel alloys, that has made many recent developments in the field of mechanical engineering possible. Thus the so-called superpressure steam plant would have been impractical had it not been for these metals, and, as a matter of fact, within the last two or three years the temperature of the steam used has gone up at least 150 deg. fahr. beyond what was considered safe only a short time ago.

The engineering profession has clearly recognised the interdependence between the ability of metals to resist high temperature and the design of such structures as, for example, the major elements in power-plant equipment. As early as 1924 a committee of The American Society of Mechanical Engineers held a symposium jointly with the American Society for Testing Materials on high-temperature metals. Another symposium will be held next June in Chicago during the annual meeting of the American Society for Testing Materials at a session on the effect of temperature on the properties of metals to be sponsored by a joint committee of that society and the A.S.M.E. This will cover the trends in the engineering requirements for metals at high and low temperatures in various industries, such as power plant, oil, chemical, ceramic, automotive, etc. Another session will deal with the properties of available metals, where the latter will be classified according to their base materials, into such groups as zinc alloys, carbon alloys, and many varieties of alloyed steels.

The tentative program was published in the *A.S.M.E. News* for November 7, 1930. Suggestions, data, etc., on the topics named as well as on others not yet included in the program should be sent to Dr. H. W. Gillett, Director, Battelle Memorial Institute, Columbus, Ohio. In view of the importance of the subject, vigorous and sincere cooperation on the part of the entire engineering profession is looked for.

The Present Status of Commercial Aeronautics

THIS subject is touched upon in passing in the report by F. Trubee Davison, Assistant Secretary of War for Aeronautics, and is discussed in considerable detail in the 1930 report of the National Advisory Committee for Aeronautics. From these it would appear that the future of the industry both in manufacturing and operating is dependent upon the solution of many problems affecting the cost and the operating efficiency of airplanes. These problems are both aerodynamical and structural. The aerodynamic problems are those affecting the safety of the airplane and, among other things, the reduction of its landing speed. Under this heading also come the problems involving freedom from noise and vibration in aircraft.

The safety element is largely dependent upon the reliability of the power plant, and economy of fuel consumption is an important factor in the cost of operation. The reliability of aircraft engines has been already greatly improved by advanced design and the selection of proper materials. Furthermore the employment of supercharging and special fuels permits an increase in the engine horsepower of from 20 to 30 per cent for a given weight, together with a reduction in fuel consumption per horsepower-hour.

According to the National Advisory Committee, in the last analysis the future of aviation may be said to depend upon the degree to which safety is increased and costs are reduced. In very plain language this means that aeronautics, unlike the automobile and the railroad in the majority of cases, in this country at least, is operating in a highly competitive field. As a military weapon the airplane, through its ability to operate in three-dimensional space, is in a class by itself. In countries like Eastern Europe, Central and Asiatic Russia, Chile, and North Africa, where other means of transportation are absent or very inefficient, the airplane again has a field of its own; but between New York and Chicago, and even New York and San Francisco, the airplane will have to fight for a big place in the transportation scheme if it wants to get it.

Engineering Progress Continues

TO BEGIN the new year with a survey of the old is a custom with MECHANICAL ENGINEERING, for it is felt that plans for the future are most intelligently laid upon a knowledge of the past. Hence the January issue is largely devoted to the reports of progress that the Professional Divisions of The American Society of Mechanical Engineers prepared for presentation at the Annual Meeting of the Society held in December, 1930.

The year 1930 will be a memorable one in industry because of the depression which brought so many vexing problems. But these problems were economic and financial, not technological. While production fell off and unemployment brought serious social and economic consequences, progress in applied science and engineering continued unabated. Research organizations worthy of the name were not disbanded nor was their work seriously interrupted, for it has been convincingly demonstrated that the fruits of research are the basis of the prosperity that follows cyclical depression. Work begun years ago and patiently pursued comes to fruition through the efforts to those who undertake it.

When economic recovery permits once more the full-time production of the industries and men now idle, those who in dull times continued to develop new machines, materials, and methods will find themselves better able to meet the competition that is sure to develop in the world's markets. Engineering progress goes forward in spite of economic set-backs, as will be clearly shown by a study of the Progress Reports.

While almost every reader of Mechanical Engineering is a specialist, he must, as a well-informed engineer, keep himself posted on what the other specialists have accomplished during the year. The Progress Reports of the Professional Divisions serve this purpose. They serve equally well students in engineering colleges. Engineering moves at so rapid a rate that textbooks cannot keep abreast of it. Yet the changing scene in mechanical engineering has been caught in these reports by experts, and they afford an opportunity for study and discussion, excellent collateral reading and reference material, and abundant opportunity for classroom and seminar discussion. They have, in fact, in the past been used as the basis of meetings, not only of student engineers but of local engineering societies.

Pipe-Line Prospects

IN THEIR recent appeal for relief to Congress, the railroads cited pipe-line competition as one of their major grievances. According to the railroads this competition in the first place is hurting their business by taking away a share of the freight which they used to haul or would have hauled had it not been for the construction of pipe lines. Next, they claim that pipe-line operation, at least in some cases, is contrary to the so-called commodity clause of the national transportation law. This clause prohibits railroads from hauling goods other than timber in the production or manufacture of which the railroads are interested.

Taking up first the legal end, the friends of pipe lines have two answers. One is that, unlike the railroad, the pipe line is not a common carrier, but transports only goods owned by the owner of the pipe line. The reason for the imposition of the commodity-clause restriction is therefore absent, and there is no fear that goods owned by railroads and carried at a lower concealed rate would come into competition with other goods not so favored. The next argument is that the commodity clause for many years has been honored in the breach more than the observance. Railroads owning coal properties did not divorce this ownership until a very short time ago. It has also been stated in print that the reason why Henry Ford sold his Detroit, Ironton, and Toledo Railroad to the Pennsylvania Company was to avoid trouble on account of the commodity clause, but a number of railroads owned by manufacturing companies are still doing business at the old stand.

As regards the economics of pipe-line competition, it can be freely stated that pipe lines are taking away a large tonnage from the railroads. They are doing it because certain commodities, such as oil, can be transported by pipe line cheaper than by rail, while certain other commodities, such as gas, cannot be transported by rail at all.

Of course, it is very unlikely that the railroads expect Congress to prohibit the carrying of oil by pipe lines, particularly in view of the fact that the pipe-line carriers represent already an investment of $400,000,000 or more. The best that the railroads can look forward to is government regulation of the interstate transportation of oil by pipe line, with the further possibility that this regulation may be made so harassing to the pipe-line industry that its development may at least be slowed down.

As a matter of fact, large-scale pipe-line development, even for oil, is a comparatively recent phenomenon. Pipe lines for gasoline have already shown their ability to pay under certain conditions, and this development is well under way. Further, there is no reason why powdered coal should not be sent by pipe line, and in fact a very earnest investigation of the possibility of doing this is under way in the United States and is believed to be also under investigation in Germany from certain unpublished information which has reached this country.

Some years ago a proposal was made to transport ordinary coal by pipe line, using water as a carrier. Nothing was done about it at the time, but the matter is again under investigation. It has also been stated that a company in the Pittsburgh district is considering the installation of a pipe line to handle cement—and as a matter of fact, any finely powdered material can be handled by pipe, provided the cost of pipe-line construction can be brought down to a sufficiently low level.

There are two ways for railroads to meet this competition. One is to have a law passed against it. However, President Hoover, in one of his early addresses, spoke of the futility of endeavoring to solve economic problems by the instrumentality of a policeman. The other way is to turn the new tendencies to their own advantage. The railroad is a transportation agency and as times change it need not remain devoted exclusively to wheel transportation on rails. It has a tremendously valuable asset in its right of way, and there is no reason why it should not lay pipe lines of its own and thus deflect the profits arising from such transportation into its own treasuries.

A Rail-Plane System of Transportation

REFERENCE has been previously made in Mechanical Engineering to the Bennie system, in which a car is suspended from an overhead track built above the ordinary railway track and driven by an airscrew. The idea of using an airscrew for propelling a streamline rail car has been also incorporated in the vehicle recently tested by the German engineer Kruckenburg near Hanover. A 462-ft. stretch of rail-plane track over the London and Northeastern Railroad line at Milngrove, near Glasgow, has recently been completed, and has enabled full-scale demonstrations of the Bennie system to be made. It is now stated in *The Engineer* (Oct. 31, 1930) that a private company in the south of France has decided to equip 30 km. of track with a Bennie rail-plane system, and that the preliminary work will shortly be begun. The equipment is to be made in England, and Wm. Beardmore and Co., Ltd., of Dalmuir, are to construct the rail-plane cars. Plans for the rail-plane system to connect the towns of Blackpool and Southport over the River Ribble have been prepared and approved by the Blackpool Corporation, and a bill in connection with this scheme is to be brought before Parliament. The plans also provide for a road over the River Ribble.

From an economic point of view the key feature of the Bennie system lies in the possibility of using the upper side of the overhead track as a high-speed motor highway. Practically any stock car can be now operated at 50 m.p.h. with safety in so far as the automobile in itself is concerned. The hazards in the fast driving of today arise practically exclusively from excessively sharp curves on the roads and from the crowded state of the highways. A special high-speed overhead highway could be used as a toll road, and the extent to which it would be patronized would tremendously affect the development of the overhead rail system.

Railways are already beginning to feel the inroads into their traffic by automobiles. It would be quite interesting to see them turn the tables and make the private automobile one of the contributing factors toward modernizing rail transportation and making it pay. It would be also a proper way to do it, because it would improve railroad transportation at the cost of making automobile transportation more attractive. One thing is certain, however, and that is that under the impetus of airplane transportation on the one hand and automobiles on the other, the railroads will have to look forward to a way of speeding up their own passenger business. It is stated in this connection that as soon as the Pennsylvania Railroad has completely electrified its New York-Philadelphia line, it will introduce a time schedule calling for 90-m.p.h. runs.

Magnetostroy and Dnieprostroy

TWO long names of sufficient importance to become part of the average engineer's geographic vocabulary. Two structures built by American engineers in and for a distant country with a social structure utterly unlike our own. Keys to an enormous plan by which it is proposed to transform in five years a country of 150 million population, 95 per cent of which up to a few years ago consisted of farmers with nearly microscopic land holdings, into a nation with a modern, and in some cases a supermodern, industrial structure.

The idea of the so-called five-year plan was not originated by the Soviet Government. As a matter of fact both the U. S. Army and the U. S. Navy had laid down "piatiletkas" (five-year plans) for the development of the aircraft programs long before any such plan was developed by the Soviet. In Magnetostroy and Dnieprostroy lies the best illustration of what the five-year plan is. Magnetostroy is a steel mill to be built on the Asiatic side of the Ural Mountains for an ultimate production of 4 million tons a year. The ore is to be obtained from the so-called Magnet Mountain, which contains an enormous supply of very pure magnetic oxide of iron. Coal is to be brought from the Kuznetzk mines 1500 miles away. No metallurgical coal is available in the Ural district, and such iron as has come from there has been smelted with charcoal, which has naturally restricted the tonnage that could possibly be produced.

The work at Magnetostroy is being done under American supervision provided by Arthur G. McKee, of Cleveland, Ohio, and will represent an investment by the Soviet Government estimated today at 800 million rubles (roughly $400,000,000).

The work began in July, 1930, and by about the beginning of November the Ural River was spanned with a dam three-quarters of a mile long. The foundations of the power plant of 236,000 kw. capacity have been completed, and by winter the entire framework and roof are to be finished. The foundations of the blast furnaces have been dug, and concrete is being poured into them at the rate of 500 cubic meters a day.

There are to be eight blast furnaces, each designed for a daily production of 1000 tons of iron. The thin-walled construction has been adopted. According to H. R. Knickerbocker in an article in the New York *Evening Post*, the American engineers believe that the plant will be finished very nearly on time, that by October of this year the first two blast furnaces will go into operation, and at short intervals thereafter the remaining furnaces will be installed.

From other sources it has been learned that the plant will include the usual blooming mill with accessories, and rolling mills. Thus far, it is understood, no orders have been given for any strip or wire mills. This is not the first steel mill to be operated in Russia by Russian labor and engineers, as several plants have been so operated there in the past. The cost of production per ton of steel will be high as compared with American costs, partly because the efficiency of the labor, and probably of management, may be expected to be lower, but mainly because the long haul of the coal will impose a heavy burden thereon. On the other hand, as the plant belongs to the Soviet Government, it does not need to charge interest on investments which are merely the product of printing presses, or cost of raw materials which are owned by the government. As a matter of fact the Soviet does not expect to be able to sell any of the products of the plant abroad and wishes merely to provide for domestic needs, and therefore competitive cost of production is immaterial.

The product of the plant will affect world trade indirectly, however, since steel from Magnetostroy will be used to build machinery, in particular, farm machinery, tractors, etc., which will permit a greater production of wheat, rye, flax, and such other goods as the Soviet can export.

The other huge project is the power plant on the Dnieper River in southern Russia, also known as the Ukraine. This project is likewise directed by Americans under the leadership of Col. Hugh L. Cooper. The dam across the Dnieper River is a mile and a quarter long and 200 ft. high. The power house is to be 820 ft. long with nine turbines of 85,000 hp. each, operating under a head of 116.5 ft. Propeller-type turbines are to be installed. Seventeen thousand workers are employed on the job. Under the Russian system of employment of labor, Sunday has been completely abolished. Instead a five-day week has been introduced so that one-sixth of the population is at liberty at all times. Piece-work wages are the rule. The dam has already been built and the stationary parts of the turbine structures are being installed. The rate of progress is shown by the fact that, for example, in September, 1930, 88,000 cubic meters of concrete were placed and in October, 1930, 110,000 cubic meters, which is more than twice the best record of construction made at Muscle Shoals. The first two turbines are scheduled to go into operation in September, 1932, and all the nine are to be completed during 1933. Mr. Knickerbocker, who gives the above figures, states, however, that there is a disposition in Dnieprostroy to believe that the installation will not be completed before 1934.

What to do with the enormous annual output of the plant would be a problem anywhere except in Soviet Russia. There the project includes not only the dam and power plant, but the building of a new city of factories to utilize the dam's power. The project as outlined now includes an aluminum plant to be built by French engineers with a capacity of 15,000 tons yearly, a ferro-alloy plant for the annual production of 260,000 tons, a cement plant, and a steel mill. Sewers and water lines have been laid for the whole project and a brick plant is in operation. Seven thousand workers are employed already on construction, and 4500 will be needed next year. A city of dwellings to be occupied by 150,000 workers by 1933 is being planned. The total cost of the various equipment and dwelling houses of the new city is estimated to be around $400,000,000. As the bulk of this cost is to be in the form of labor and products made in Russia from Russian materials, there is little reason to doubt that, barring entirely unforeseen events, the project will be completed. It will require, however, a sum estimated at $150,000,000 to be spent for equipment of the various plants, mostly in America, but the Soviet Government has shown its ability to spend that much money in two years already.

With American firms of the highest standing directing the design and construction of Russian plants, there is no reason why they should not be built at least as well as the average American plant. American engineers will supervise the organization of work without being hampered by any restriction on stopwatch clocking of labor operations, the Soviet being heartily in favor with the idea of rationalization or Fordization, which are the common names in Russia for what we call scientific management here. With the plants organized by American engineers and the managing personnel including foremen trained by them, there is no reason why they should not have a rate of production at least approaching that of American plants. Out of the 150,000,000 population of Russia, it will certainly be possible to select thousands of men capable of operating the plants; as a matter of fact, American steel mills, for example, are largely operated by labor of the type to be found in Soviet Russia, so that a cousin of the roller at Magnetostroy may be performing the same job in Gary or Pittsburgh. All this being true, there is no reason why the Russian mills should not prove reasonably successful. What it will mean to the trade in raw materials and to American and Canadian farmers is a different matter.

The 51st A.S.M.E. Annual Meeting

Some Impressions of a Week of Discussion of Engineering Subjects, and of Social and Technical Events, in Which More Than 2500 Engaged

THERE are certain features of every annual meeting of The American Society of Mechanical Engineers that make each one memorable. Sometimes it is a paper, broad and significant, destined to become a classic of engineering literature. Sometimes it is a ceremonial function at which honors are bestowed on persons of great importance. For some, it is a first experience. Others find it an occasion where the professional spirit is revivified and friendships are renewed. A different kind of a program may have added zest for the sophisticates. New fields of knowledge and new points of view may quicken the interest of those whose lives are becoming cramped by routine and lack of contacts. Opportunity for comment is open to the critical. And thousands of little adventures, trivial and momentous, add humor, annoyance, and variety, and in some instances provide the means by which men's lives are completely changed. Twenty-five hundred persons assembled from all parts of the country and took part in and witnessed the same series of events, and there have resulted 2500 individual and different impressions. In the interests of frankness, therefore, let it be stated that the impression set forth in what follows is but one of the 2500, and chance alone offers the opportunity of its serving vicariously those who may not have been present in person.

ROY V. WRIGHT — PRESIDENT, 1931

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Of this year's features, of which more will be said later, impressions linger of an exhibition of art by engineers; of some excellent addresses on "Talking With an Audience" and of the personality that gave spirit and meaning to the words; of two eminent engineers who received honors and by so doing did honor to those who honored them; of the vigorous and charming personality of the President-Elect of the A.S.M.E.; of the rapt attention with which the speaker at the banquet was listened to, of the contrast of his ascetic figure, uttering his challenging message with earnest conviction and prophetic zeal, with that of customary after-dinner speakers with their platitudes and polite inanities; of the manner in which industrialists and economists discussed their common problems, and of the differences which still exist in their points of view; of the message delivered by the chairman of President Hoover's Emergency Committee for Employment; and of many excellent technical papers, fruitful committee meetings, excursions, and social events.

Because of the unavoidable absence of President and Mrs. Piez, Colonel and Mrs. Doty acted on their behalf on President's Night. Colonel Doty as senior member of the Council in length of membership in the Society, also presided at the Council meeting, at the Business Meeting on Monday, at the Council Dinner Tuesday evening, and at the opening of the Council Meeting on Friday, at which time the new officers and members of the Council were introduced and the gavel presented to Roy V. Wright, President of the A.S.M.E. elected at the 1930 Annual Meeting.

Other duties of President Piez were ably performed by other vice-presidents. Charles E. Gorton presented the special badges to Fifty-Year Members of the A.S.M.E. at the dinner on Wednesday evening, Conrad N. Lauer delivered the "Charge to New Members" at this same dinner, William Elmer presided at the luncheon of the Council with the Local Sections Delegates on Monday, and R. L. Daugherty at the luncheon of the Council with the Student Branch Delegates on Wednesday. Ralph E. Flanders represented President Piez at the dinner, on Monday night, of the executive officers and representatives of the Professional Divisions. All of the vice-presidents represented the President at the authors' breakfasts and luncheons, and invested the presiding officers of the technical sessions with presidential authority for these occasions.

"Talking With an Audience"

For many years the A.S.M.E. has been making a constructive and sincere attempt to improve the conduct of its technical sessions and the manner in which papers are presented. A scheme of bringing the authors and presiding officers together at a breakfast or luncheon preceding their public appearance has worked well. Those officiating at a given session have thus been given an opportunity to become acquainted with each other; authors have been imbued with a spirit of friendliness and sympathy for their sometimes initial efforts at public address, and presiding officers have been instructed in the mechanics of their duties. Improvements have been noticeable, but perfection has not been reached—probably never will be.

The services of a coach in public speaking were engaged for a few years so that authors might receive personal instruction immediately prior to the presentation of their papers. While many profited by these helpful services, the plan was abandoned this year in favor of another which brought benefit to a greater number. After all, not much can be done for an author a few hours prior to his appearance. But the ideals to be striven after by all who may present papers, immediately or in the future, cannot

be too frequently stated, and this year the series of three talks by S. Marion Tucker, professor of English, Polytechnic Institute of Brooklyn, on "Talking With an Audience" were thoroughly enjoyed and very favorably received.

It is quite an accomplishment to assemble at 8:50 in the morning as large an audience as faced Professor Tucker Tuesday, Wednesday, and Thursday. The word spread around after the first day that the talks were very much worth while, and even some of the skeptics came in to listen, and be convinced. First of all the engaging personality of the man who gave the talks was largely responsible for the favorable impression they created. After all, one is convinced on hearing Professor Tucker that, unless an oration is contemplated, "talking with an audience," which is what one does in addressing a technical session, is a very simple matter. It is merely necessary to know in a general way what points are to be brought out, and then to talk about them as intelligently and convincingly as possible. Professor Tucker sent his audiences away so charmed with his success that every one wanted to go out and try his luck at doing the same sort of thing to another audience. He gave a number of practical suggestions also, and his offer to send to any one interested mimeograph copies of his suggestions will undoubtedly be eagerly accepted.

Unfortunately Professor Tucker's ability to talk with an audience was not instantly and successfully communicated to all of those who presented papers and presided at meetings. But this was no fault of Professor Tucker's, and there is no question but what many an individual who listened attentively and will conscientiously apply the suggestions and criticisms to his own platform style will greatly improve it to his own satisfaction and to the great benefit of those whom he addresses. Professor Tucker's talks were an outstanding feature of the meeting.

THE HUMAN PROBLEM

Elsewhere in this issue of MECHANICAL ENGINEERING will be found the address entitled "The Engineer Encounters Human Nature," delivered by Prof. Elliott Dunlap Smith, of Yale University, at the A.S.M.E. Annual Dinner. Those who heard the dramatic presentation on Wednesday night—and more than one thousand heard it—will be glad of the opportunity of reading it at their leisure. Others, while missing the personality of the man who delivered it, will still be inspired by the burden of his message.

The address was memorable from three points of view: the manner of its presentation, the sincerity and conviction of the speaker which made the audience feel that he was thoroughly familiar with his subject-matter, and what was said. It is no mean feat to stand on a rostrum in the Astor Ballroom and hold an after-dinner audience of one thousand spellbound, not by brilliant oratory and fine rhetoric but by the burning zeal of a prophet. A not too robust body, dark, studious eyes that penetrated his hearers, emphasized the power that the honest ascetic can wield on occasions when an audience is pleasantly conscious of its own well-being. There was plenty of vivid contrast between the ornate splendor of a metropolitan banquet hall and the picture of squalor and stupid management of a southern mill town that Professor Smith painted. No one dozed, no one left the room, but all sat with eyes intent on the speaker absorbed in his story. It was an indictment and a challenge—an indictment of engineers blind to their social obligations, a challenge to them to make the consequences of the technological progress for which they are responsible truly a blessing to humanity rather than a scourge.

STABILIZATION OF EMPLOYMENT

The following résumé of the discussion at a most important all-day conference on this subject was prepared by George E. Hagemann, associate editor, Alexander Hamilton Institute, New York, who arranged the session and the discussion.

Upward of two hundred executives, engineers, and members of various commissions studying the employment problem attended the round-table conference on the stabilization of employment under the auspices of the A.S.M.E. Management Division and the American Management Association. The present industrial depression, with its acute unemployment problem, was recognized by the conference as one solely of an economic nature. The causes that stand out clearly are: (1) a certain amount of overproduction; (2) strenuous but costly efforts to stimulate increased consumption; (3) unintelligent price cutting; (4) excessive wastes in distribution; (5) a general alarm over the acuteness of the situation that causes industrial plants to undertake drastic retrenchment; (6) a consequent reaction on the public that reduces sales and consumption; (7) a repetition of the vicious cycle on decreasingly smaller production schedules that continuously reduce employment.

To aggravate the present situation, conditions abroad are similar to those in the United States, and there is no extensive foreign market to absorb a certain portion of American products and assist in relieving the home conditions.

Lack of real industrial leadership is the basic cause of the violent fluctuations of the industrial cycle.

Many plants—some large and some small—have solved the employment problem for themselves by forecasting sales, setting reasonable sales quotas, planning annual production schedules on a uniform monthly basis, maintaining their labor forces intact, and prospering as a result. But these plants cannot solve the problem, single-handed, for the nation at large. Similar intelligent management is required of every plant, large or small.

Mechanization of industry must continue because the course of progress must not be stopped. Such improvements, and development of methods that increase production, however, can be carried on in a manner that will not bring about an upheaval. The program must be correlated with the development of the new industries that spring up in answer to new human wants, and absorb the labor released by improvements in the older industries

A sharp distinction exists between the approach of the engineer and that of the economist to the question of continued high wage rates. The industrial executive and the engineer agree that the present wage scales must be maintained, and that any necessary adjustments of labor earnings must come solely through reducing the hours of labor. The economists take the older and now probably ineffective method of endeavoring to adjust wage scales to current conditions. The economic soundness of this idea is open to serious question, entirely aside from the attendant danger of strikes and labor troubles that are almost certain to result.

Industrial leaders among both executives and engineers are almost unanimous in the belief that any reduction in the standard of living would be a most unfortunate backward step This conviction is held not only with regard to the executive, engineering, and "white-collar" group, but also equally with respect to the rank and file of labor.

The problem of unemployment was held to be mainly the responsibility of business and industry. Social relief and Government measures were regarded merely as temporary, though at present necessary, expedients. Government commissions to collect, analyze, and present data with regard to production and employment, for the guidance and use of industrial organizations, would be of definite aid. Government projects in the line of public works, if undertaken on an extensive scale, would relieve emergency situations. But a 10-year program of activity, covering all

industries, and built constructively along the lines of discovering the true extent and volume of human needs, and a regularizing of production to meet those needs—producing no more than the market can well absorb—would do more than anything else to put employment on a stable basis and prevent future periods of business depression.

Economist and Engineer

In a subsequent issue of Mechanical Engineering will appear the addresses delivered on Tuesday evening by Ralph E. Flanders, manager, Jones & Lamson Machine Co., Springfield, Vt., and

Elliott Dunlap Smith

Dr. Wesley C. Mitchell, director of the National Bureau of Economic Research, New York, which discussed engineering, economics, and the problem of social well-being.

Magnus W. Alexander, president of the National Industrial Conference Board, New York, presided during the delivery of the addresses, or "debate." In his introductory remarks, Mr. Alexander quoted the well-known lines of Kipling to the effect that "the Colonel's lady and Judy O'Grady are sisters under their skins," and prophesied that the debate would feature two winning contestants.

It appeared that the engineer and the economist are in fair agreement about the ridiculousness of the situation in which this country finds itself today, but while the engineer is confident that in so far as technology and industrial organization for production are concerned, difficulties do not exist or are unimportant, the economist is conscious of innumerable factors which are not subject to physical law or susceptible of easy control. Mr. Flanders asserted that we are awaiting the unborn "social engineer," and predicted that the solution this individual might formulate would be found to consist of changes of viewpoint and new rules of action for all of us. Dr. Mitchell showed that the problem centered in the workings of a vast social machine, and concerned the economic behavior of millions of men. The schemes to provide an "omniscient dictator," a soviet of engineers, or a committee of doctrinaire communists served by technicians, implied, he said, that the mass of mankind should surrender its economic liberty to some higher authority. He felt that progress was being made slowly. The very drift of affairs was coercing us to change. Why not mix all the intelligence we can muster into the process of making over our own habits? If engineers, he concluded, would join with the other professions now working constructively on the problem, our progress would be accelerated.

Colonel Woods' Appeal

At a special conference, assembled at the request of the American Engineering Council, who had been asked by Col. Arthur S. Woods, chairman of President Hoover's Emergency Committee for Employment, to sponsor a study of what industry has done to stabilize employment, both during the present crisis and in the past, L. W. Wallace, executive secretary of the American Engineering Council, and Colonel Woods presented the problem to the A.S.M.E.

In his address Colonel Woods referred to the paper on the engineer as an economist presented to the A.S.M.E. in 1886 by Henry R. Towne as an epoch-making one because it inaugurated a new movement in management in this country. The present unemployment crisis, said Colonel Woods, had its greatest hope for solution in a persistent and intelligent attack by men who were both engineers and economists.

Colonel Woods referred to the conference on unemployment which Herbert Hoover, as Secretary of Commerce, had called in the depression of 1920–21, and used as his text the following statement made by Mr. Hoover at that time. "There is a solution somewhere, and its working out will be the greatest blessing yet given to our economic system, both to the employer and the employee." Colonel Woods said that he knew of no group in our nation occupying a functional relation to industry who could contribute more to the practical solution of this grave problem than the engineers.

After a recital of the facts of the present depression and the resulting suffering due to unemployment, Colonel Woods reviewed some practical plans used by industrialists to lessen the burden of unemployment, speaking specifically of those employed by Procter & Gamble, Leeds & Northrup, Brown & Bailey, Dennison Manufacturing Company, Columbia Conserve Company, Deering, Milliken & Company, Crocker-McElwain Company, United Diamond Works, Manning Paper Company, S. C. Johnson, and the General Electric Company.

He did not, he said, intend to convey the impression that the whole problem of unemployment could be dealt with by the efforts of individual managements working at the tasks of regularization in their own concerns. These examples, he said, emphasized the fact that we were expecting a high measure of effort and intelligence from the captain of a ship, no matter how severe might be the storm by which the vessel was buffeted.

Carrying out his metaphor, Colonel Woods said that we must be fundamental enough in our thinking to find out what caused this economic typhoon. The present situation he pointed out as being grave, stupid, and anomalous.

> We have abundant—seemingly superabundant—resources of raw materials, man power, manufacturing, transportation, and distribution facilities. We also have a seeming plethora of fluid capital. On the one hand, we have idle workers—hundreds of thousands of them—able to work, exceedingly anxious to do so, and desperately in need of the things which they might produce if they had the opportunity; on the other, we have idle plants which the owners very much desire to have in operation, and, in many cases, desperately need to set working for financial reasons. Yet we do not know how to bring the two together. No one profits by the situation. Every one loses. It seems to be nobody's fault. It has come about as the result of uncontrolled economic forces which are not well understood.
>
> I submit that industrialists, economists, and statesmen should now address themselves wholeheartedly to the correction of this stupid situation, with a fixed determination to stay on the job until it has been mastered.
>
> In the midst of the crisis of the World War the Government asked each industrial and responsible organization to aid in winning the war. There was a remarkable response—the members of this great society of engineers tendered and performed gallant service.

Today we are going through a grievous national crisis, and again the engineers are coming forward to do their bit. They will play an effective part, and a powerful part. Can we not hope that it may be a determining part?

Colonel Woods' invitation from the President's Emergency Committee on Employment to the A.S.M.E. to cooperate in the current emergency was presented to the Council of the A.S.M.E. by L. W. Wallace. It met with earnest consideration and hearty expressions of cooperation, and a resolution was passed setting forth the attitude of the Council. According to the resolution the Society will (1) urge industry to adopt measures immediately to relieve the winter emergency; (2) compile data as to effective policies and methods used to deal with the general question of irregular employment; and (3) assist in all other practicable ways. The Council further authorized President Wright to appoint a committee to organize and direct this work. The matter was then referred to the A.S.M.E. Local Sections Conference where it was enthusiastically endorsed, with promises of loyal support and cooperation. On December 13, President Wright announced the personnel of the committtee as follows: Ralph E. Flanders, chairman, Dexter S. Kimball, Ely C. Hutchinson, Joseph W. Roe, Col. C. H. Crawford, and Col. W. A. Starrett. President Wright and Secretary Rice are members ex-officio.

Local Sections Delegates

The business transacted by the A.S.M.E. Local Sections Delegates is essentially of a character best reported through the *A.S.M.E. News*, in the December 22 issue of which the record will be found. It is not out of place, however, to call attention here to the fact that these men, and their associates at home, render most important service to the profession of engineering by their interests and activities on behalf of it and its practitioners. They are representative, in more than one sense of the term, of the professional mechanical engineer. They bring the problems and the suggestions of their constituents to a common forum, and carry back reports of sentiment and activity in other parts of the country. They are thus in miniature the A.S.M.E. membership itself, and seeing them all together in one place gives one an impression of what that membership is.

Elihu Thomson Made an Honorary Member of the A.S.M.E.

On President's Night, Tuesday, December 2, Elihu Thomson was made an honorary member of the A.S.M.E. Professor Thomson was presented by Ambrose Swasey, honorary member and past-president, A.S.M.E., and honorary membership was conferred by Col. Paul Doty, vice-president, A.S.M.E., acting for President Charles Piez.

In presenting Professor Thomson, Dr. Swasey read the following citation.

"Professor Elihu Thomson, teacher, inventor, engineer, scientist:

"In your school days it was said that you were particularly interested in chemistry and physics. As time went on the future possibilities in electrical development especially appealed to you, and in 1875 you built your first model dynamo. In the following year, when twenty-three years of age, although appointed to the chair of chemistry and mechanics in the Central High School of Philadelphia, you were invited to deliver a series of lectures on electricity at The Franklin Institute, the apparatus used in connection with these lectures being of your own design and construction. In 1877 you designed and constructed arc-light machines, one of which was shown in operation at The Franklin Institute. These, with the many other electrical instruments and appliances which you invented and constructed, show that you were one of the pioneers in the new Electrical Age.

"You certainly have kept to the front in the wonderful progress that has been made in the Electrical Age for the good of mankind.

"Among the most distinctive of hundreds of your inventions is the art of welding steel by electricity. Its range of application covers an innumerable line of products, from the small elements of machines, automobiles, and airplanes to the uniting of miles of piping in the oil and gas industry and the framework of large buildings.

"You were one of the founders of the General Electric Company, and still take an active and important part in its work.

"In the field of education you have been especially interested in the Massachusetts Institute of Technology, and served as its Acting President from 1921 to 1924.

"You have been the recipient of many honors, including honorary degrees and memberships, beautiful and expressive medals and decorations.

"For several years past you have been engaged in developing methods for the production of fused quartz, which, because of its non-expansive qualities, is of the greatest importance to science and industry.

"Many years ago you accomplished the difficult feat of making the ten-inch refracting lens for the telescope which still stands in your home observatory. Now, in the afternoon of your life, you have again manifested your interest in astronomical science by undertaking the very welcome task of producing a disk of fused quartz seventeen feet in diameter, two feet in thickness, and weighing approximately twenty-seven tons. This great disk will be the 200-inch reflecting objective for the telescope to be erected on the Pacific Coast by the California Institute of Technology. When completed it will be the greatest and most important monument ever erected to science.

"The splendid breadth of your achievements, the result of your active brain and busy hands, and your endearing personality have won for you the esteem and appreciation of all who know you and know of you."

Professor Thomson has a total of 700 patents in the United States of America alone, and the list of his scientific and engineering achievements is a long and impressive one.

Other awards and honors to Professor Thomson are the following:

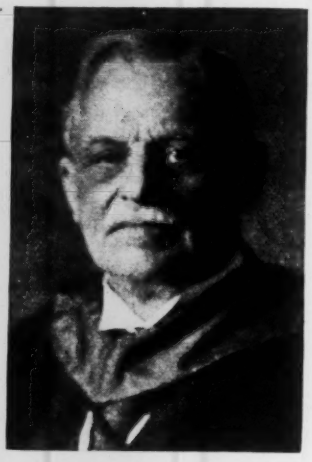
He has received twice the John Scott Legacy Medal and Premium of The Franklin Institute; the Rumford medal (1902) of the American Academy of Arts and Sciences; the Hughes medal (1916) of the Royal Society of Great Britain; the first Edison medal (1910) of the American Institute of Electrical Engineers; the Elliott Cresson gold medal (1912) of The Franklin Institute; the John Fritz medal (1916) given by the four principal America-engineering societies; the Lord Kelvin medal (1924) by the Kelvin Medal Committee representing the Royal Society, the civil, mechanical, and electrical engineering societies, and the Society of Naval Architects of Great Britain, which award was seconded by the four principal American engineering societies; the Franklin medal (1925) by The Franklin Institute; the Faraday medal (1927) by the Institution of Electrical Engineers, London; appointed member of the World Engineering Congress, Tokyo, Japan, 1929; the Grand Prix at the Paris expositions of 1889 and 1900, and half of the first prize in the Paris electric-meter competition of 1890. He was also made Officier et Chevalier de la Légion d'Honneur in 1889. He holds the following honorary academic degrees: A.M., Yale, 1890; Ph.D., Tufts College, 1894; D.Sc., Harvard, 1909, and University of Manchester, England, 1924; and L.L.D., University of Pennsylvania, 1924.

Professor Thomson has been very active in the work of electrical organizations, such as the American Institute of Electrical Engineers, of which he became one of the earliest presidents, and

represented this body in London in 1889 at a meeting in the Guildhall, at which the British leaders in science and engineering and about 300 visiting American engineers were present. He served as president of a number of international bodies of electricians, among which was the International Electrotechnical Commission, where he succeeded Lord Kelvin, of England, and Mascart, of France.

ADMIRAL DAVID WATSON TAYLOR AWARDED THE JOHN FRITZ GOLD MEDAL

For outstanding achievement in marine architecture, for revolutionary results of persistent research in hull design, for improvement in many types of warships, and for distinguished service as chief constructor of the United States Navy during the World War, Admiral David Watson Taylor was awarded the John Fritz Gold Medal at the Annual Dinner of the A.S.M.E. on Wednesday evening. Lincoln Bush, chairman of the John Fritz Medal Board of Award, presided. The address on the career and achievements of Admiral Taylor was made by Walter M. McFarland, past-president, Society of Naval Architects and Marine Engineers, and past-vice-president of The American Society of Mechanical Engineers, and the medal was presented by Bancroft Gherardi, chairman of the board which made this award and past-president of the American Institute of Electrical Engineers.



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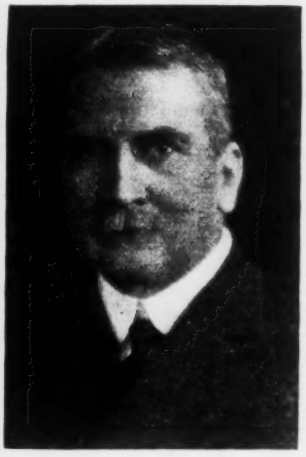

DAVID WATSON TAYLOR

The John Fritz Medal is an honor given jointly by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. It is awarded not oftener than once a year for notable scientific or industrial achievement. It was established in 1902 in honor of John Fritz, of Bethlehem, Pa., pioneer ironmaster and engineer

Admiral Taylor was born on a farm in Louisa County, Virginia, March 4, 1864. He was educated at Randolph-Macon College, the United States Naval Academy, and the Royal Naval College, Greenwich, England, where he specialized in naval architecture and marine engineering.

While still a student at Greenwich, Admiral Taylor was appointed assistant naval constructor. He served for six years at Washington, Philadelphia, and San Francisco, and in 1894 returned to the Navy Department at Washington as principal assistant to the chief naval constructor. His connection with this bureau continued throughout the remainder of his active career in the Navy, during which he was advanced to the rank of rear-admiral. From 1914 to 1922, a period which included the World War, he was chief of the Bureau of Construction and Repair. He was retired at his own request on January 15, 1923.

Admiral Taylor has received the Distinguished Service Medal of the United States of America. He is a commander of the Legion of Honor, France; an honorary fellow of the Northeast Coast Institution of Engineers and Shipbuilders; an honorary member of the Society of Naval Architects and Marine Engineers, an organization which he has also served as president; and of the Institution of Engineers and Shipbuilders in Scotland. He is a member of the Institution of Naval Architects, Great Britain, and of the National Academy of Sciences, United States of America. He has received honorary degrees from Stevens Institute of Technology, George Washington University, Randolph-Macon College, and the University of Glasgow, Scotland.

THE OPENING TECHNICAL SESSIONS

It was on Monday morning that the technical sessions began, getting off to an early and auspicious start with two simultaneous gatherings devoted to lubrication engineering and applied mechanics. While these were in progress, the 1930 Council met for the last time, the Local Sections Delegates assembled to hear the chairmen of the standing committees of the A.S.M.E., and numerous committee meetings got under way.

At the lubrication-engineering session, W. F. Parish, chairman of the Committee on Lubrication Engineering of the A.S.M.E. Petroleum Division, outlined its functions and purposes, pointing out especially the comprehensive study being carried out on the history of lubrication with special reference to the variation of the characteristics of the lubricant with the design and operating characteristics of the machine. It is expected that the data so assembled will show the trends in characteristics and application of lubricants

About one hundred representatives of different phases of lubrication engineering attended the session and participated actively in the discussion of the three papers. From the papers and resulting discussion it was evident that the Division is meeting a need in providing an outlet for the presentation and discussion of subjects in the field of lubrication of interest to the engineer. The desire to cooperate with other professional divisions of the A.S.M.E. in the solution of problems of mutual interest was expressed.

The session on applied mechanics, and the one which followed it on Monday afternoon, served to emphasize the growing interest of industrial organizations in the application of mathematical analysis to design problems. It is a healthy and auspicious sign that industry in this country is willing to finance research of the type represented by the papers which the A.S.M.E. Applied Mechanics Division sponsored at its sessions. It is also a healthy sign that those engaged in this research are able to keep their feet on the ground, as their papers exhibit little tendency toward abstract mathematical development. The mathematical theories developed are subjected to and are controlled by rigid physical tests, and the results are practical and dependable.

With the Monday morning sessions safely out of the way, the technical sessions swung into their accustomed stride. It is not the object of this report to review the papers or discussions presented in complete form. The Transactions of the A.S.M.E. will contain the revised papers and the edited discussions, and may be studied by those interested in the subjects treated. For the basis of the comments on the technical sessions expressed in this report, the reviewer is grateful to the several staff representatives who attended the sessions and made notes of significant impressions.

RAILROAD SESSIONS

The two sessions of the A.S.M.E. Railroad Division afforded opportunity for the presentation of three technical papers and the Division's progress report by title. The progress report will be found elsewhere in this issue of MECHANICAL ENGINEERING. Of the three papers, two were of unusual interest to locomotive men and the third to car designers. At the request of the Division, C. F. Hirshfeld, chief of research, Detroit Edison Company, reviewed the progress which has been made in stationary steam-power plants in the use of high pressures and temperatures, and with this experience and knowledge as a background, he told how he would attack the problem of locomotive design. It is the intention to publish a liberal abstract of Mr. Hirshfeld's paper in an early issue of MECHANICAL ENGINEERING so that his interesting views may be considered by a larger group of engineers than the members of the A.S.M.E. Railroad Division.

The application of the unit pulverizing system of coal firing to locomotives was discussed in the paper by R. Roosen, chief engineer, Henshel & Sohn A. G., Cassel, Germany, who described the Stug system now in operation on German railways. The paper contained test and operating data.

To the paper by T. H. Symington, of T. H. Symington & Son, Inc., Baltimore, entitled "Research Relating to the Action of 4-Wheel Freight-Car Trucks," an entire session was devoted. The paper and the discussion dealt with the possibility of decreasing railroad-truck derailment losses by means of an improved design of truck. Many narratives of personal experiences with derailments resulted in the discussion.

INDUSTRIAL ACCIDENT PREVENTION

A symposium on industrial accident prevention, under the auspices of the A.S.M.E. Standing Committee on Safety, was the occasion for the presentation of three papers, two of which, by L. P. Alford and Lucian W. Chaney, appeared in the December issue of MECHANICAL ENGINEERING. The third, by L. W. Wallace, executive secretary, American Engineering Council, Washington, D. C., dealt with some economic aspects of industrial casualty reductions.

In carrying on educational work to further work in industrial accident prevention, the humanitarian aspect has generally been stressed and the economic aspect usually overlooked. In the three papers and discussions on them at this session, it was clearly brought out that accident prevention pays, and that this fact is realized by the larger companies, with the result that they have undertaken systematic measures to make their shops more safe. By far the greater percentage of accidents resulting in loss of time for the workman occur in the smaller shops. Small-shop managers are prone to assume that the cost of accidents is borne by the company with whom they are insured. Such is not the case, however, as their accident-insurance costs are based on their past record, and in that way they pay in following years for accidents which occur today.

FUELS

An observer of long standing in the A.S.M.E. Fuels Division might remark that from eminently practical discussions of methods of firing fuel, emphasis had been shifted to the theory of combustion radiation. An article on "Combustion Radiation and the Planck Quantum Theory," which ran through the past four issues of MECHANICAL ENGINEERING, serves as a further proof of this tendency. The session of the A.S.M.E. Fuels Division confirms the observation, for here the interest was centered on heat absorption and radiant heat transmission. Apparently we have paused for a moment from the more easily comprehended consideration of powdered fuel, stokers, firing technique, and combustion conservation and control to ask ourselves what the invisible mechanism by which energy in the form of heat of combustion as transmitted to the water and steam within the boiler actually is. And this question unfortunately involves some knowledge of the physical and mathematical sciences.

A consensus of opinion as brought out in the discussion of the two papers by W. L. DeBaufre and H. C. Hottel at this session seems to be that while the papers offered represent valuable contributions to the subject of heat transmission and absorption by radiation from the fuel bed to the water-cooled surfaces, our knowledge of the effect of the many variables coming into the problem still makes it necessary that expert judgment be used in applying the equations derived. The expert judgment, of course, comes in determining the values of the coefficients entering into the equations given in the papers and the variables which influence the selection of the many factors involved, such as the degree of cleanliness of the tubes, variation in temperature over the surface of the fuel bed, and the amount of reflected radiation which may come from the side walls or other non-heat-absorbing surfaces.

GENERAL SESSION

The general session held on Wednesday morning unfortunately involved the overshadowing of an extremely good paper on the machining of cold-drawn steels by a somewhat controversial one on the mechanics of pipe bends. Professor Boston's paper on machining of cold-drawn steels was extremely interesting to all who deal with the cutting of metals and was very well presented. However, there were so many members of the audience anxious to discuss and criticize the paper on pipe bends, that those who wished to discuss machining of cold-drawn steels did not get very much opportunity to do so. Both papers were well supported by lantern slides, which always add much to the presentation of any paper.

HYDRAULIC SESSION

Only two papers were presented at the session sponsored by the A.S.M.E. Hydraulic Division, one highly technical, well done, and well presented, but too involved to invite intelligent discussion without previous study of the preprint; and the other of a more general type, better suited to quick understanding and formulation of opinions.

The fact that the audience remained attentive throughout indicates that the subject-matter treated, or the individuals actively participating, had a real interest for everybody.

The report of progress in the hydraulic field published elsewhere in this issue of MECHANICAL ENGINEERING, occupied a place of importance and interest. It provoked some discussion and applause. Blake R. Van Leer offered the suggestion that the scope of future reports be widened to include several other related subjects not treated in this year's report, a suggestion which seemed to meet with general approval.

As a result of the discussion of the paper by F. E. Bonner, executive secretary of the Federal Water Power Commission, presented at this session, the Division passed a resolution to the effect that it recommended to the Council of the A.S.M.E. that the Council sponsor the formation of a committee to be known as the Engineers' Water-Power Policy Committee, and that the committee be composed of five members, two of which are to be appointed by the American Engineering Council, one by The American Society of Mechanical Engineers, one by the American Institute of Electrical Engineers, and one by the American Society of Civil Engineers. The Council of the A.S.M.E. voted to refer the Division's resolution to the American Engineering Council, with the suggestion that such a committee

as that mentioned in the resolution be set up in the American Engineering Council.

INDUSTRIAL POWER

Both papers presented at the session on industrial power under the auspices of the A.S.M.E. Power Division had previously been presented at the Second World Power Conference, Berlin, Germany, June, 1930. Their subject-matter was of great interest and no opportunity had been offered in this country of discussing the papers from the point of view of engineers on this side of the Atlantic. As was evident from the many able discussions, the topics are live ones. B. F. Wood, president, Allied Engineers, Inc., New York, had for his subject "Engineering Aspects of Interchange of Power with Industrial Plants," and W. F. Ryan, mechanical engineer, Stone & Webster, Inc., Boston, Mass., spoke on "Combined Heat and Power Supply in Industrial Plants." Both papers indicate that engineers are paying strictest attention to the industrial power plant and are applying to the problem the same careful consideration of all possible economic and technical features that has so long been characteristic of their studies of central-station plants. The complications introduced by interconnection with central-station plants demand careful study, but the growing realization of the importance of the power and heat problem to industrial plants seems to justify close scrutiny.

MATERIALS HANDLING

The A.S.M.E. Materials Handling Division held three sessions, two of which were devoted to technical papers and the Division's progress report, and a third, under the auspices of the Manufacturers' Committee, to the reports of six subcommittees on classification of materials-handling equipment and nomenclature; performance standards of locomotive cranes and crawlers; capacity of containers; cross-reference index for equipment; cooperative research; and educational possibilities.

The technical papers were devoted to materials-handling equipment for the shoe, rubber, and cereal industries, and for chain-store warehouses. The papers were well illustrated by lantern slides, which added greatly to the interest on the part of the audience, and the ensuing discussion was lively. A brief summary of the extensive progress report of the Materials Handling Division will be found elsewhere in this issue of MECHANICAL ENGINEERING.

MACHINE-SHOP PRACTICE

At the two sessions sponsored by the A.S.M.E. Machine Shop Practice Division, four technical papers and the Division's progress report were presented. The latter will be found elsewhere in this issue of MECHANICAL ENGINEERING.

An observer at these sessions was impressed by the fact that the younger men were in the majority as authors and discussers of papers. This would indicate that at least the subjects discussed this year were of a nature in which research and new methods were prominent. Two of these papers dealt with the use of motion pictures in industry and the use of the spectroscope, coming in the category of new methods, while a third was a study of the transmission of torque by means of shrink and press fits. The fourth paper was a survey of surface quality standards and tolerance costs based on 1929–30 precision-grinding practice.

MECHANICAL SPRINGS

At the session devoted to mechanical springs the outstanding thought developed seemed to be that an immense amount of research still remains to be done before a complete theory of spring behavior can be formulated. Some of the discussion indicated that certain special types of springs that were under consideration might not be commercial manufacturing possibilities.

SAFETY AND WOOD INDUSTRIES

Two papers and the progress report of the A.S.M.E. Wood Industries Division, printed elsewhere in this issue of MECHANICAL ENGINEERING, were presented at the session on Safety and Wood Industries. In presenting his paper on dust explosions, Hylton R. Brown, of the Chemical Engineering Division, U. S. Department of Agriculture, Washington, D. C., demonstrated by means of a model how such explosions take place. The extent of the explosion which resulted from a very small amount of material in the model surprised every one.

In the second paper, on "Research in Wood Products," by James W. Lawrie, director of chemical research, A. O. Smith Corporation, Milwaukee, Wis., the work being done at this corporation's laboratory was discussed.

TEXTILES

The A.S.M.E. Textile Division devoted its session to problems relating to the machinery of textile plants, one paper dealing with special applications of electric motors to cloth-finishing plants, and the other to the lubrication of textile machinery.

APPRENTICE TRAINING

Under the auspices of the A.S.M.E. Committee on Education and Training for the Industries, the subject of apprentice training was discussed at a session on Wednesday afternoon. Progress in this field in Virginia and Wisconsin was presented by C. F. Bailey, of Newport News, Va., and Harold S. Falk, of Milwaukee. The opportunities that exist for aviation training were set forth by Joseph A. Marriott, chief of inspection service, Aeronautics Branch, Department of Commerce.

STEAM-TABLE RESEARCH

In accordance with a custom of several years' standing, the reports presented at the meeting of the A.S.M.E. Special Research Committee on the Thermal Properties of Steam will be published in the February issue of MECHANICAL ENGINEERING. Reports of the work at Massachusetts Institute of Technology and the Bureau of Standards were presented. Prof. J. H. Keenan presented a paper on "Thermal Properties of Compressed Liquid Water," and Dr. Harvey N. Davis spoke delightfully of the International Conference held last June in Berlin.

AMERICAN MANAGEMENT IN EUROPE

In addition to the fruitful all-day round-table conference on stabilization of employment, the A.S.M.E. Management Division, cooperating with the American Management Association, met to discuss a paper by Wallace Clark on "American Management in Europe," and the Division's progress report. The main portion of Mr. Clark's paper was published in the December, 1930, issue of MECHANICAL ENGINEERING, and the progress report will be found elsewhere in this issue.

AERONAUTICS

Because of the volume of the material submitted by the A.S.M.E. Aeronautics Division in its annual progress report, only a brief abstract of that document will be found (elsewhere) in the current issue of MECHANICAL ENGINEERING. The report was submitted at the Thursday session under the auspices of the Division, at which time a paper on airplane cabin engineering, and a report on airplane instrument vibration, were also presented.

CUTTING METALS

Recent developments in materials for cutting metals have been

reported at technical meetings and in the technical press from time to time, and because of the importance of the subject to machine-shop practice and the lack of comparative data which would make it possible to choose the proper material for a given purpose, the three papers presented under the auspices of the A.S.M.E. Special Research Committee on Cutting of Metals were particularly welcome. The cutting materials discussed were tool steels, cemented tungsten carbide, and Haynes stellite. An observer at the session remarked an absence of commercialism in the discussion, which seemed to have been offered chiefly for the purpose of real enlightenment and the spreading of knowledge on the subject of the more recent metal-cutting materials.

Oil and Gas Power

A pleasant feature of the session sponsored by the A.S.M.E. Oil and Gas Power Division was the presentation to Geo. J. Dashefsky, assistant mechanical engineer, Diesel engine section, U. S. Navy Yard, Brooklyn, N. Y., of the Rudolph Diesel Award for the best paper delivered at the 1930 National Meeting of the Division. The paper discussed problems of vibration in Diesel-engine crankshafts. Also on the subject of vibration was a paper by Frederic P. Porter, who has presented other papers in this field before the A.S.M.E., the one on this occasion dealing with a simple method for calculating natural frequencies of torsional vibration. The progress report of the Division, to be found elsewhere in this issue of MECHANICAL ENGINEERING, was also presented.

Central-Station Power

Two modern high-pressure central stations, Deepwater and Holland, were discussed at the central-station session of the A.S.M.E. Power Division. Operating experience to date on these two stations, as well as on others which were mentioned during the discussion, seems to show conclusively that there are no insurmountable obstacles to be encountered in the operation of plants at pressures of around 1300 lb. per sq. in. The boilers themselves have given no trouble whatever, and the troubles that have developed in the auxiliaries are being overcome. One very satisfactory feature of these papers is that both of the authors have been able and willing to tell of the troubles experienced in the early stages of the operation of these plants. To do this, and at the same time refrain from casting reflections on the product of any manufacturer, is seldom achieved. If such information is given more freely by designers and operators of plants, it will very materially aid in the improvement of design and operation.

Flat-Bed Cylinder Presses

The attention of the A.S.M.E. Printing Industries Division this year was devoted to the subject of flat-bed cylinder presses. Several makes of this type of press were described in a symposium which occupied two sessions, and the problems of design and operation were discussed. In addition to the study of the presses, attention was drawn in two papers to the problem of standardization in the printing industries. One paper discussed the subject from a general point of view, while the other dealt specifically with sizes and tolerances for metal fits. The progress report of the Division will be found elsewhere in this issue of MECHANICAL ENGINEERING. Two resolutions were adopted at the session, one commending paper manufacturers for their campaigns to guide the consumer in the standardization of paper sizes, and the other requesting the A.S.M.E. to appoint a committee to investigate and report on the need for standardization in the printing industry.

Properties of Metals

Under the auspices of the Joint Research Committee (A.S.M.E. and A.S.T.M.) on the Effect of Temperature on Properties of Metals, two important papers were presented by C. L. Clark and A. E. White, of the University of Michigan. One dealt with non-ferrous alloys and the other with the comparative physical properties of chromium-nickel, chromium-manganese, and manganese steels.

Lubrication Research

Interest in lubrication research for many years has been stimulated by the A.S.M.E. Special Research Committee on Lubrication. At a session sponsored by this committee its fifth progress report was offered for discussion, together with a paper by Albert Kingsbury dealing with problems in the theory of fluid-film lubrication and advancing an experimental method of solution. The report reviewed work in progress in this country and abroad, and contained an excellent bibliography.

Refrigeration

A customary feature of the A.S.M.E. Annual Meeting is the joint session with the American Society of Refrigerating Engineers. This year the A.S.M.E. contribution to the meeting was by Daniel C. Lindsey, physicist of the Carrier Engineering Corporation, who presented a paper entitled "Psychrometry and the Effects of Air Conditioning on Some Familiar Products." Prof. W. R. Woolrich, of the University of Tennessee, presented the A.S.R.E. paper, which dealt with the effect of humidity on the heat transmission of galvanized pipe.

Boiler-Furnace Refractories

While the method of attacking the problem of erosion of boiler-furnace refractories by various coal-ash slags was handled in radically different ways by the authors of the papers on this subject presented under the auspices of the A.S.M.E. Special Research Committee, each of them offered something in the way of a definite basis by which different kinds of brick may be judged for use with different kinds of coal-ash slags. It seems that no one refractory will best meet all conditions of operation, the chemical composition of slag determining to a large extent the kind of refractory best suited to the conditions. The wide use nowadays of water-cooled walls in connection with large steam generators has solved many of the difficulties formerly met with in boiler-furnace refractories, but there will always be many places in furnace design where the refractory material will be required, so that work along these lines should continue until a selection of a proper refractory for any given condition may be more accurately determined.

Meetings of Research Committees

Fifteen research committees held meetings with a total attendance of 180 persons. In addition six of these committees sponsored technical sessions of the general meeting devoted to recent researches on steam tables, hard metal-cutting tools, boiler-furnace refractories, high-temperature properties of metals, lubrication, and mechanical springs. Certain announcements coming out of the committee meetings are of interest.

During the coming year W. R. Webster, vice-president, Bridgeport Brass Company, will head the A.S.M.E. Research Committee, the standing committee of the Council responsible for the administration of the Society's research activities.

A comprehensive symposium on the properties of metals at high temperatures will be conducted by the joint A.S.M.E.-A.S.T.M. research committee of that name during the A.S.T.M. Annual Meeting in Chicago in June, 1931.

Real progress is being made by another committee in the development of safe and accurate formulas for the design of vessels subjected to external pressure, and suitable for inclusion in the A.S.M.E. Boiler Code. A discussion of the problem by Commander H. E. Saunders was received by his hearers with great interest.

The Special Research Committee on Cutting of Metals has reorganized in order to more effectively prosecute its diversified program. W. W. Nichols, of Detroit, continues as chairman. Prof. Orlan W. Boston gave a report, illustrated with slides, of the experimental investigation on cutting fluids which he is conducting for the committee at the University of Michigan. The Tungsten Carbide Subcommittee has broadened its scope to include study of all types of hard metal-cutting tools and their effect on machine-tool design.

Prof. Earle Buckingham presented a voluminous report to the Committee on Strength of Gear Teeth summarizing the past five years' experimental work on the Lewis gear-testing machine. This report contains highly useful data on the effect of dynamic loads on the strength of gear teeth, and is being printed in pamphlet form by the Society.

The Fluid Meters Committee has been invited to recommend an American representative for membership on the proposed International Standards Association's committee to develop standards for fluid-flow measurement.

J. R. Townsend, Bell Telephone Laboratories, and C. T. Edgerton, Crucible Steel Company, are now directing the affairs of the Mechanical Springs Committee as chairman and secretary, respectively.

The Committee on Lubrication reported that a selected group of important foreign and domestic contributions to the literature on lubrication have been collected and translated by the Committee for publication by the Society.

Bert Houghton, vice-chairman of the Condenser Tubes Committee, presented a report of further experiments on the effect of oxygen in condenser water on tube deterioration.

Chairman Trinks of the Committee on Heavy-Duty Anti-Friction Bearings announced a substantial contribution to its fund by a large steel company. Progress made in the study of forces acting on roll-neck bearings, stresses in roll necks, and roll deformations was reviewed.

A subcommittee of the Research Committee Diesel Fuel Oil Specifications met to review its proposed program of physical research on fuel oils and discuss the laboratories available to carry it out.

Power Test Codes

At the meeting of the Main Committee on Power Test Codes on the morning of Monday, December 1, 1930, which was attended by twenty-eight members of the main committee and the several individual committees, Secretary Le Page reported that two additional test codes had been published since the last meeting. These codes are the "Test Code for Liquid Fuels" and the "Test Code for Atmospheric Water-Cooling Equipment." The publications make a total of 20 of the 24 test codes, and four sections of "Instruments and Apparatus," of the Committee's program completed to date.

A. T. Brown, reporting for Individual Committee No. 10, stated that a second draft of the "Test Code for Centrifugal and Turbo-Compressors and Blowers" had been distributed to the members of the individual committee for study. It is expected that the individual committee will meet early in January to go over further changes or additions which may seem necessary before the code is released to the main committee.

A finally revised draft of the "Test Code for Complete Steam-Electric Power Plants" based on the criticisms received at the public hearing in June, 1930, was presented by Chairman R. J. S. Pigott.

The work of Individual Committee No. 19 on "Instruments and Apparatus" has progressed satisfactorily. The progress report showed that about 70 per cent of this committee's program has been completed. Three additional parts of "Instruments and Apparatus" will soon be published in pamphlet form, having recently received the approval of the Council as standard practice of the Society. These parts are Part 11, Measurement of Quality of Steam; Part 13, Speed Measurement, and Part 17, Determination of Viscosity of Liquids.

There was a short discussion of the activities of the Main Committee in its relationship with the International Electrotechnical Commission through its membership on the U. S. National Committee, I.E.C. Announcement was made of the appointment by the President of Messrs. Fred R. Low, C. Harold Berry, Francis Hodgkinson, William F. Durand, Harvey N. Davis, Ely C. Hutchinson, Irving E. Moultrop, and Paul Diserens as the Society's representatives on the U. S. National Committee. Three members of the Power Test Codes Committee have also been named by the U. S. National Committee as directors of secretariats in the prime-mover field: Dr. William F. Durand for Hydraulic Turbines, Dr. Fred R. Low for Steam Turbines, and Francis Hodgkinson for Internal-Combustion Engines.

Meetings of Technical Committees

During the Annual Meeting the A.S.M.E. Technical Committees held forty-three meetings on Research, Standards, Power Test Codes, Boiler Code, and Safety. These meetings had an attendance of 565.

At its meeting on Thursday, the A.S.M.E. Standardization Committee elected H. Birchard Taylor chairman for the next year, and recommended the appointment of B. H. Blood as the 1931 appointee to the Committee. The appointment of L. K. Sillcox, vice-president, New York Air Brake Company as the Society's representative on the American Standards Association replacing H. B. Taylor, resigned, was approved. W. S. Monroe, president, Sargent & Lundy Company, was recommended for appointment as the Society's representative on the Mechanical Standards Advisory Council. This meeting was followed by the annual luncheon at the Engineers' Club of the A.S.M.E. Standardization Committee and the chairmen of standards committees for which the Society is sponsor. The attendance was thirty-seven, and the group was addressed by E. J. Kearney, retiring chairman of the Standing Committee.

Among the important standardization meetings were four on the Code for Pressure Piping: Refrigeration, Power Piping, Fabrication Details, and District-Heating Piping. The Subcommittee on Fabrication Details discussed important sections on welding of pressure piping which had been approved by the American Welding Society, as well as the fabrication of hangers, supports, anchors, sway bracings, and vibration dampeners. Subcommittee No. 2 on Power Piping discussed several proposed changes in its tentative draft of July 10, 1930. At the meeting of the Sectional Committee held on Wednesday the reports of the various subcommittees were received and discussed. Efforts to develop a section on hydraulic piping were discontinued at the request of the American Water Works Association.

The meeting of the Subcommittee on Plumbers' Threads received reports from its subgroups on the Study of Existing Thread Dimensions of Cocks and Stops, and Fine Threads for Tubing. A recommendation for the standardization of 28 threads per inch on thin brass and copper tubes was approved.

At the meeting of Subcommittee No. 9 on Socket-Head Cap and Set Screws of the Sectional Committee on Bolt, Nut, and Rivet Proportions, the question of tolerances on the external

dimensions tentatively set up for socket-head cap and set screws was considered in detail. It was generally agreed that tolerances allowed should be finer than those specified in the American Standard for Slotted-Head Proportions, particularly with respect to diameter and height of head.

The organization meeting of the Sectional Committee on the Standardization of Pressure and Vacuum Gages was held on Friday afternoon with an attendance of twenty-three. This Committee will undertake the standardization of pressure, vacuum, and combination pressure and vacuum gages; indicating type; nomenclature and definitions; requirements of accuracy; methods of expressing accuracy; methods of testing; specifications; rules for installation and use; gage sizes and mounting dimensions; connections and gage cocks, size, etc.; capacity ratings and ranges; continuous working capacity; graduation, markings, and space for trade mark and name plate, etc.; indicator hands, bushings, and micrometer adjustment; stop pins; and bezel rings and their attachment.

For some time the Sectional Committee on Plain Limit Gages for General Engineering Work has been undergoing reorganization. The reorganization meeting was held on Friday morning with twenty-four present. Edward J. Kearney presided as permanent chairman of the committee. Plans were made for the work of revising the present standard for Tolerances, Allowances, and Gages for Metal Fits, and completing the task included within the scope of this project by the American Standards Association. The chairman was empowered to appoint such subcommittees as he deemed necessary to review the subject.

At the annual meeting of the Sectional Committee on the Standardization of Small Tools and Machine-Tool Elements, the progress reports of its fifteen technical committees were reviewed and discussed. The Technical Committee on Punch and Die Holders met prior to the Sectional Committee to discuss the replies received to the questionnaire on die-set design and construction which has been broadly distributed. This Committee expects to complete its recommendations shortly. The Technical Committee on Cut and Ground Thread Taps, which has had one standard approved, met to discuss the additional proposals for ground-thread pulley taps; cut- and ground-thread bent-shank taper taps; and cut-thread taper taps, machine-screw sizes.

The meeting of the Subcommittee on Engineering and Scientific Graphs of the Sectional Committee on Graphic Presentation took the form of an open meeting and was held on Thursday, at which it discussed the Appearance Factors in Engineering Graphs. A paper was read by H. F. Dodge, and prepared discussions were presented by A. R. Thompson, A. G. Hanscom, A. H. Richardson, and W. A. Shewhart, chairman of the subcommittee.

The Sectional Committee on the Standardization of Pipe Flanges and Fittings, Dean C. P. Bliss, chairman, met on Saturday morning. The following actions were recorded: (1) Change of rating 250-lb. steel flanges and fittings to 300-lb. approved; (2) 800-lb. cast-iron hydraulic fittings approved with changes, and (3) steel companion flanges referred back to Subcommittee No. 3.

H. W. Mowery was elected chairman for the coming year, and a nomination was prepared for the 1930 appointment to the Committee.

Boiler Code Committee

A meeting of the Boiler Code Committee was held on Friday, December 5, at which in addition to its regular interpretation work, a hearing and audiences were granted to associations and manufacturers who were interested in obtaining revisions of the rules. The hearing was granted to representatives from the petroleum interests who were petitioning the Committee for liberal provisions for welding in the construction of pressure vessels. A report of an extensive series of tests upon the continuous and progressive electric resistance butt-welding process was considered at some length with a view to granting a request of a pressure-vessel manufacturer for recognition thereof, and assignment of a working-stress allowance for their type of joint. Among the subjects considered at the meeting were several devoted to problems in welding, such as seal welding on riveted joints, stress relieving for welded pressure vessels, button-welded joints, welding of miniature boilers, and the proposed Specifications for Fusion Welding of Pressure Vessels. In addition, special consideration was given to questions concerning alloy steel for stays and staybolts, construction details for spherical vessels, a test on a large jacketed vessel, requirements for small-size tubes for fire-tube boilers, and hydrostatic-test pressure requirements.

Annual Meeting Committees

Credit for the success of the Fifty-First Annual Meeting of the A.S.M.E. is due to the individual and organized efforts of the committees who handled the arrangements. These committees are as follows:

A.S.M.E. COMMITTEE ON MEETINGS AND PROGRAM

William L. Batt, *Chairman*
George M. Eaton
Frederick M. Feiker
James W. Parker
Collins P. Bliss.

COMMITTEES ON NON-TECHNICAL EVENTS

Collins P. Bliss, *Member, Committee on Meetings and Program, in Charge*

RECEPTION COMMITTEE

S. K. Barrett, *Chairman*
A. A. Adler
G. F. Bateman
E. F. Church
S. W. Dudley
A. V. Farr
P. R. Faymonville
V. Federici
R. M. Gates
M. Giannini
W. M. Graff
A. C. Harper
O. H. Henry
R. F. Jacobus
J. S. Kerins
G. L. Knight
C. W. Lytle
T. B. J. Merkt
D. M. Myers
J. W. Roe
F. M. Van Deventer
V. Wichum.

INFORMATION COMMITTEE

E. E. Mariner, *Chairman*
R. A. Cole
T. W. D. Schafer
S. Z. Weiner
J. Rosenthal.

COMMITTEE ON EXHIBITION OF ART BY ENGINEERS

L. P. Alford, *Chairman*
J. W. Roe
G. F. Bateman
Mrs. F. M. Gibson
Mrs. A. H. Morgan.

PRESIDENT'S NIGHT COMMITTEE

A. A. Adler, *Chairman*
M. B. Richardson, *Vice-Chairman*
H. B. Jones, *Ushers*
G. E. Hagemann, *Catering*
H. Madsheim, *Music*
F. M. Gibson, *Courtesy*
C. O. Streeter, *Decorations.*

DINNER COMMITTEE

P. R. Faymonville, *Chairman*
A. D. Blake, *Vice-Chairman*
H. H. Hall
H. A. Gerken
P. A. Salmon
C. W. Bryden
T. V. S. Skinner
R. C. Dehmel
C. M. Vernon
F. A. Scheffler
Mrs. F. M. Gibson.

EXCURSIONS COMMITTEE

E. C. M. Stahl, *Chairman*
E. D. Barry
W. C. Beattie
A. C. Davis
P. B. Dungan
R. K. Hartig
W. H. Lawrence
C. L. Seymour
V. Wichum
C. Wikstrom.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the Engineering Foundation, Inc., as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Water-Power Development in Germany

DIE WASSERKRAFTWIRTSCHAFT DEUTSCHLANDS. By Fritz Lippert, Leo Galland, and Adolf Ludin. V.D.I. Verlag, G.m.b.H. Berlin, 1930. Cloth, 9 × 12 in., 391 pp., photographs, charts, graphs, maps. 25 r.m. (approximately $6.25).

REVIEWED BY BLAKE R. VAN LEER[1]

THIS is a special work prepared for the Second World Power Conference recently held in Berlin, Germany, by the authorities of the German Republic and affiliated states. The chief editors, Fritz Lippert, Leo Galland, and Prof. Adolf Ludin, are all well-known authorities in Germany in the field of hydroelectric development. The publication is made possible by the united efforts of the individual hydroelectric companies of Germany which for such purposes function through an organization that in the United States would be called a holding company or trust. The publication was also supported by the German manufacturers of hydraulic and hydroelectric machinery.

The first impression given by the publication is that of its beautiful, artistic appearance: the excellent quality of the paper, the clear, bold type with numerous attractive photographs, the tasteful presentation of the seals of the various German states—all combine to make this an extremely admirable work of the publisher's art.

It is believed there is an English edition under the title of "The Water-Power Exploitation of Germany." A more correct translation of the spirit of the title of the book seems to be "The Water-Power Industry of Germany" or "The Development of the Water-Power Industry of Germany."

With characteristic German thoroughness the authors have started at the beginning and discussed the geology and physical resources of Germany—the rainfall and its relation to run-off and evaporation. Charts and graphs elaborately explain and clarify the relation between elevation, rainfall, run-off, and evaporation.

The industries which use electrical energy with their annual consumption are given, as well as the total kilowatt-hours used in each state. The percentage of the total energy produced in various states which comes from water or hydroelectric power varies from nothing in the seacoast province of Hamburg to 72.8 per cent in Bavaria.

A description of every large hydroelectric installation in Germany is given in considerable detail, and the peculiar characteristics of each province are fully set forth. Naturally the provinces which receive the most attention are those which have potentially and in service the largest amount of hydroelectric power. However, the authors present the most complete picture in existence of the hydroelectric facts as they exist in the states of Prussia, Saxony, Baden, Thuringen, Wurttemberg, and Bavaria. In each of these important states, the power developments and possibilities are treated according to the river or drainage area from which the power is derived.

Extensive and effective use is made of many large aerial photographs which show in an excellent manner the intake, discharge, and general layout of every important hydroelectric plant in Germany.

"Die Wasserkraftwirtschaft Deutschlands" is factual, descriptive. It is undoubtedly a most thorough piece of work of its kind, and for the hydroelectric engineer who desires to know the facts concerning his profession as practiced in Germany, it should be exceedingly useful.

[1] Assistant Secretary, American Engineering Council, Washington, D. C. Mem. A.S.M.E.

Diesel-Engine Operation, Maintenance, and Repair

DIESEL ENGINE OPERATION, MAINTENANCE AND REPAIR. By Charles H. Bushnell. John Wiley & Sons, Inc., New York, 1930. Cloth, 6 × 9, 285 pp., 192 figs., tables, $3.50.

REVIEWED BY LOUIS R. FORD[2]

IN THE preface to this book the author states, in effect, that the purpose of the volume is to give the operator of Diesel engines a few hints as aids in operation and maintenance. Reading of the first few chapters is likely to create the impression that the operator will be more confused than aided by the contents.

Certain special topics such as combustion, vaporizing, mixing, injection, etc., are discussed by the method of abstracting from various published articles and books and presenting the information without any systematic or logical arrangement. No discussion of the Diesel engine as a complete machine is attempted. The first ten chapters are not likely to convey any clear and definite information to the man who needs it, and will probably be understood only by those who are already familiar with the subjects discussed. In the chapter on vaporizing, mixing, and ignition systems, all the methods of mechanical, or airless, injection of fuel are given the type designation of "Vickers System," because the Vickers engine was the first to use successfully airless injection of fuel into a Diesel-type combustion chamber. It would be just as logical to call all double-acting engines

[2] Consulting Engineer, Brooklyn, N. Y. Mem. A.S.M.E.

"Burmeister & Wain Type Engines" because Burmeister & Wain were the first Diesel manufacturers to make a commercial success of the double-acting principle.

In the discussion of air-injection fuel valves the statement is made that "it is not possible to ascertain the exact action of atomization, mixing, and combustion in an engine cylinder." These actions are then given the quality of exactness by specific explanations, the correctness of which are, to say the least, highly debatable.

From Chapter X on the author is on firmer ground, and the text is more in accord with the title of the volume. In this part is contained the real value of the book. The chapter on valves and valve timing is particularly good. In all the succeeding chapters the author displays a comprehensive knowledge of operation and maintenance problems, although his reasoning is not always good. No one should try to deprive the engineer of his pet hobbies, but the claim made in Chapter XIII that dirty crankcase oil is often best for cooling off hot bearings may be discounted by the fact that many analyses of dirty crankcase oil have established the fact that the larger portion of the solid matter in such oil is metal dust and not carbon.

Such criticisms as may appear in the foregoing should not, however, obscure the merits of this volume, which is evidently the outcome of practical knowedge and may be considered a very valuable addition to the small list of books that discuss the Diesel engine from the point of view of the man who has to run it and keep it in repair.

The nine chapters devoted to operating and repair problems contain much to confirm the statement on page 257 that "the most important qualifications of an engineer are good judgment and ability to get the work done."

Weld Design and Production

WELD DESIGN AND PRODUCTION. By Robert E. Kinkead. The Ronald Press Company, New York, 1930. Cloth, 5¾ × 8⅜ in., 108 pp., 54 figs., $4.

REVIEWED BY T. MCLEAN JASPER[3]

THIS book attempts to clarify and organize the general line of reasoning as to the position which welding has assumed to date with regard to its reliability and where it can be applied

Obviously with an art developing so rapidly the matter cannot be covered at this time to the fullest limit of the development already attained. Yet the general user of welded products will be materially helped by a close study of this volume, unless he is very much acquainted with the research and development work of those who are in the vanguard of such development.

To the writer there is today no middle course open to the welder of steel, which is dictated by economics, in which he may offer to his customer a joint which has lesser qualities than the plate jointed. The author, however, intimates that under certain conditions there may be reasons why this can be done.

The designer of welded joints too frequently cleaves to types of joints most suited to other processes of fabrication, and is unable to mentally adjust himself to the practical possibilities of welding. This might be emphasized more by the author.

The welder who offers a metal in the weld which differs more than the normal physical specification for plate material from the plate material, is not applying to the problem the best available welding practice. This is not appreciated to the full in the book.

Adequate testing, where possible, of the final welded product not only insures a good product but spurs the welding personnel to produce quality. The economics of the effect and value of testing is very loosely handled by the author. The cost of severely testing the final product, where possible, very much more than pays for itself eventually in reducing the necessary weight of a product to safely care for a particular service.

The book is so general in nature that it becomes exceedingly difficult to review it with the satisfaction which a reviewer generally desires. It is helpful in giving hints that may develop trains of thought which can become exceedingly valuable to the user of welded products as well as the welding engineer.

[3] Director of Research, A. O. Smith Corp., Milwaukee, Wis. Mem. A.S.M.E.

Thomas Davenport—Pioneer Inventor

THOMAS DAVENPORT—PIONEER INVENTOR. By Walter Rice Davenport. The Vermont Historical Society, Montpelier, Vt., 1929. Cloth, 6 × 9, 165 pp., illus., $2.

THIS in a way is a remarkable, certainly an unusual, book. Thomas Davenport was born in 1802 and by profession was a blacksmith in the village of Brandon, Vermont. He might have led there that passive life with its human joys and sorrows that has been so well described by Longfellow in his "Village Blacksmith," but once he saw an electric battery, and this changed the whole course of his life. A study of electricity soon resulted in his invention of an electric motor. The story of the building of the motor, including the incident when his wife sacrificed the only silk dress she had or was ever likely to have to provide insulation for the wires, is a charming human document. The motor was built and patented, draining in the course of its construction the financial resources of the inventor. We know now, of course, that no electric motor could work economically that depended for its source of power on expensive batteries. It was only after Faraday's discoveries had led in the hands of Edison and Westinghouse to the development of the steam-engine-driven generator that the electric motor became commercially profitable. Unfortunately for him, however, Thomas Davenport could not know this. His motor worked, and he was unable to see any reason why it should not be adopted by the industries. Throughout the remainder of his life he struggled to interest capital in the manufacture of electric motors two generations before they were to come into common use, and with heart-breaking failures and disappointments.

The book pictures well the life of the generation of American inventors that bridged the agricultural stage of the period between the war of 1812 and the discovery of gold in California, when the foundations of many of the most important modern machines were laid by men with an inordinately keen vision into the industrial future.—L. C.

Books Received in the Library

AN INTRODUCTORY TO THE STUDY OF WAVE MECHANICS. By Louis de Broglie. E. P. Dutton & Co., New York, 1930. Cloth, 6 × 9 in., 249 pp., $4.25.

This account of the theory of wave mechanics originated by De Broglie will be welcomed by physicists generally. Beginning with the ideas underlying the theory, he develops the subject in logical sequence. The principle of indeterminateness is discussed, and recent experimental work on electronic diffraction is described.

JAHRBUCH 1930 DER DEUTSCHEN VERSUCHSANSTALT FÜR LUFTFAHRT, E.V., Berlin-Adlershof. Edited by Wilh. Hoff. R. Oldenbourg, Munich and Berlin, 1930. Cloth, 9 × 12 in., 688 pp., illus., diagrams, tables, 58 r.m.

The year-book of this active research institution is an important

contribution to aeronautic literature. In addition to reports on the activities of the organization, it contains reports on fifty-eight researches completed during the past year. The reports cover a wide variety of practical and theoretical questions relating to aerodynamics, statics, engines, materials, aviation, and radiotelegraphy.

DER LEISTUNGSFAKTOR. By G. Scharowsky. (Siemens-Handbücher, bd. 7.) Walter De Gruyter & Co., Berlin and Leipzig, 1930. Cloth, 6 × 8 in., 197 pp., illus., 7.50 r.m.

Reviews the importance, source, and effects of reactive power, and discusses the methods of improving the power factor which have been devised. The measurement and computation of reactive power are also discussed. The book is based on the researches and experience of Siemens & Halske and the Siemens-Schuckertwerke.

MASCHINENELEMENTE. By H. Krause. Fifth edition, revised by W. Tochtermann. Julius Springer, Berlin, 1930. Bound, 6 × 9 in., 456 pp., illus., 16.50 r.m.

Treats of the design of the common elements of machines, such as riveted and screw joints, wedges, axles, crankshafts, couplings, bearings, gearing, etc. in a simple, practical fashion, without the use of higher mathematics. The book is intended as a text for intermediate schools and as a reference book for practical men.

MATERIALPRÜFUNGSWESEN. By K. Memmler. Fourth edition. Walter De Gruyter & Co., Berlin, 1930. 3 vols. Cloth, 4 × 6 in., illus., diagrams, 1.80 r.m. each.

These three little volumes by the Director of the German National Laboratory for Testing Materials give a surprisingly complete description of present methods of mechanical testing. Volume one contains methods of testing metals for strength, hardness, elasticity, malleability, etc. Volume two covers stone, cement, wood, paper, textiles, rubber, varnishes, coal, and water. Volume three gives tests for machine elements—belts, ropes, chains, gears; for railroad material; and for lubricants. It also describes testing machines and instruments, and methods for calibrating them. A useful bibilography of some 450 titles is included.

DER MENSCH IM FABRIKBETRIEB. Edited by F. Ludwig. Julius Springer, Berlin, 1930. Bound, 6 × 9 in., 204 pp., illus., diagrams, tables, 16.50 r.m.

The nine addresses here collected under the general theme of the man in industry are those delivered before the Society of German Factory Engineers in 1928–1929. They discuss various factors that affect the health and efficiency of workmen, including such matters as the prevention of fatigue, the psychology of accidents, lighting in relation to production, the influence of dust on output, the arrangement of workrooms, hygienic measures for women, and industrial cooperation.

DIE NEUZEITLICHE DAMPFTURBINE. By E. A. Kraft. Second edition. V.D.I. Verlag, Berlin, 1930. Cloth, 8 × 10 in., 214 pp., illus., 20 r.m.

A critical review of modern tendencies in steam-turbine construction, by the engineering director of the largest European turbine manufactory. Dr. Kraft treats practical questions from a practical viewpoint, especially those that are still unsettled. The illustrations show examples of the designs of all the turbine works of the day.

THE NEW PHYSICS. By Arthur Haas. Third edition. E. P. Dutton & Co., New York, 1930. Cloth, 5 × 8 in., 172 pp., illus., diagrams, tables, $2.15.

The electromagnetic theory of light, molecular statistics, the electron and quantum theories, the theory of the chemical elements, and the theory of relativity and gravitation are the topics that Dr. Haas discusses. Without any use of mathematics he gives a clear, general view of the ideas that are now interesting physicists, and of modern views upon the constitution of matter and the laws that govern it. Readers without special training in physics will find the book intelligible.

OPTICAL ACTIVITY AND HIGH TEMPERATURE MEASUREMENTS. By F. M. Jaeger. (George Fisher Baker non-resident lectureship in chemistry at Cornell University.) McGraw-Hill Book Co., New York, 1930. Cloth, 6 × 9 in., 450 pp., illus., diagrams, portraits, tables, $4.

Contains three series of lectures delivered at Cornell University during 1928–1929 by Professor Jaeger of Groningen University. The first series surveys modern views concerning relations between certain geometrical and physico-chemical properties of atomic systems, as they appear in the molecules of certain substances. The second reviews the methods for measuring high temperatures which have been developed at Groningen University, the results obtained, and the problems awaiting solution. The third series is concerned with the problem of the constitution of ultramarines.

PERSONENKRAFTWAGEN, KRAFTOMNIBUS UND LASTKRAFTWAGEN IN DEN VEREINIGTEN STAATEN VON AMERIKA. By Emil Merkert. Julius Springer, Berlin, 1930. Cloth, 6 × 9 in., 356 pp., illus., 29.50 r.m.

An examination of automobile passenger and freight transportation in the United States, with particular reference to the economic problems involved and to its effect upon the railroads. The development of motor transport, the economics of motor trucking, the economic limits of railway competition, regulation of motor traffic, motor-bus lines, highway financing, and the social, cultural, and economic effects of the automobile are considered.

PRAKTISCHE HÄRTEREIFIBEL. By Victor Fabian. V.D.I. Verlag, Berlin, 1930. Paper, 6 × 8 in., 92 pp., illus., 5 r.m.

Intended to give the practical man proper instructions for hardening modern steels. Simple methods of testing steels and of determining proper temperatures are given, with suggestions on the hardening of various tools and machine parts. Alloy steels are also discussed.

PRÜFANSTALT FÜR FEUERFESTE MATERIALIEN. By L. Litinsky. Otto Spamer, Leipzig, 1930. (Monographien zur Feuerungstechnik, vol. 11.) Paper, 6 × 9 in., 127 pp., illus., 7 r.m.

A useful review of the best and most used apparatus for the analysis and testing of refractory materials, as used in the principal German laboratories.

REGELN FÜR ABNAHMEVERSUCHE AN VERBRENNUNGSMOTOREN UND GASERZEUGERN EINSCHLIESSLICH IHRER ABWÄRMEVERWERTER. R.A.V. Second edition. V.D.I. Verlag, Berlin, 1930. Paper, 8 × 12 in., 8 pp., 80 r.m.

These regulations for acceptance tests of internal-combustion engines and gas producers are based upon specifications formulated jointly in 1906 by the Society of German Engineers, the Association of German Engine Works, and the Association of Large-Gas-Engine Manufacturers. The present edition has been revised in the light of recent advances in engine construction.

REGELN FÜR ABNAHMEVERSUCHE AN WASSERKRAFTMASCHINEN. Second edition. V.D.I. Verlag, Berlin, 1930. Paper, 8 × 12 in., 8 pp., illus., 1.50 r.m.

These rules for acceptance tests of hydraulic turbines have been formulated by a joint committee of the German associations of

engineers and hydraulic interests, with the cooperation of Austrian and Swiss societies. The present revision corresponds to the standards of the International Electrotechnical Commission.

DIE RELAISSTEUERUNGEN DER MODERNEN STARKSTROMTECHNIK. By Reinhold Rüdenberg. Julius Springer, Berlin, 1930. Paper 6 × 9 in., 79 pp., illus., diagrams, 7.50 r.m.

A concise account of modern applications of control apparatus, by the chief engineer of the Siemens-Schuckertwerke. Present tendencies are discussed, the field of control apparatus described, and the elements of relays and switches explained. The principle of their action is presented and examples of their use given.

RITTER DER VERGANGENHEIT UND SCHMIEDE DER ZUKUNFT. By W. Ostwald. V.D.I. Verlag, Berlin, 1930. (Deutsches Museum. Abhandlungen und Berichte, vol. 2, no. 1.) Paper, 6 × 8 in., 31 pp., illus., 1 r.m.

Professor Ostwald's eloquent address discusses the origins of the present cultural crisis, tracing it to a present balance of power between the forces of the past and the forces of the future. The present inability of science, the youngest cultural force, to control events is ascribed to its extreme youth.

The librarian of the Deutsches Museum gives a brief description of the resources and aims of its library.

SCHNITTE UND STANZEN BD. 2; Biegestanzen und Biege-Verbundwerkzeuge. By Ernst Göhre. Otto Spamer, Leipzig, 1930. Bound and paper, 6 × 9 in., 230 pp., illus.; paper, 20 r.m. bound, 23 r.m.

The second volume of this treatise on punching and stamping treats of bending dies. The methods of achieving various forms are described in detail, the aim being to assist the engineer in designing suitable dies for a desired shape. Further volumes will discuss drawing dies and die construction

SCIENCE AND THE SCIENTIFIC MIND. By Leo. E. Saidla and Warren E. Gibbs. McGraw-Hill Book Co., New York, 1930. Cloth, 6 × 8 in., 506 pp., $3.

Contains twenty-four essays by such past and present scientific leaders as Tyndall, Huxley, Shaler, Pupin, Millikan, and Haldane, discussing Science, the Scientific Mind, Scientific Motive, Science and Culture, the Place of Science in a Liberal Education, Science and Civilization, and Science and the Future. While intended primarily as a textbook in composition, readers who wish an insight into the mental attitude or habit of thought of the scientist will find the book useful.

SELLING TRANSPORTATION. Edited by Albert S. Richey. N. Y. American Electric Railway Association, New York, 1930. Cloth, 6 × 9 in., 214 pp., illus., $2.

This volume records the outstanding accomplishments of seven electric railway companies, as shown by their records submitted in competition for the Coffin award of 1928 and 1929. The work describes methods of increasing patronage and revenue, winning public cooperation, lowering costs, increasing reliability and safety, and improving management and labor relations.

SHEET STEEL AND TIN PLATE. By R. W. Shannon. Chemical Catalog Co., New York, 1930. Cloth, 6 × 9 in., 285 pp., illus., $5.

This is the only existing book that gives a detailed description of the manufacture of sheet steel. The machinery and processes used in producing the various commercial varieties, and the qualities of these finished products, are explained fully. The chief aim of the author is to assist consumers in the choice of the best products for any given purpose, but his book will be of use to producers as well.

SIEMENS JAHRBUCH, 1930. V.D.I. Verlag, Berlin, 1930. Cloth, 6 × 8 in., 562 pp., illus., diagrams, portraits, 12 r.m.

The year-book presents a great number of papers by various members of the technical staffs of the cooperating firms. The central theme this year is the distribution and use of energy, and the papers discuss new inventions and ideas about power cables, reaction turbines, large transformers, switching apparatus, telephone cables and apparatus, automatic control, etc. Other papers deal with electrical mining and metallurgical equipment, electric welding, sound films, and other topics. The book is popular in style and is profusely illustrated.

STAHLBAU. Edited by Otto Bondy. (Schweisskonstruktionen, bd. 1.) V.D.I. Verlag, Berlin, 1930. Cloth, 9 × 12 in., 16 pp. text and 100 plates, 12 r.m.

One hundred photographs illustrating the use of welding in the erection of bridges and buildings. The photographs are taken from various American and European structures and illustrate the wide variety of ways in which welds can be substituted for riveted joints. Brief descriptions accompany the plates, and references are given to fuller published accounts. The book is sponsored by the Welding Division of The Verein Deutscher Ingenieure.

DER STAHLBEHÄLTERBAU. By E. Kottenmeier. Wilhelm Ernst & Sohn, Berlin, 1930. Paper, 7 × 10 in., 55 pp., illus., diagrams, 3.20 r.m.

This pamphlet contains a good account of steel tank construction. The development of present types is discussed, with descriptions of oil tanks, silos, gas tanks, and water towers. Methods of design are discussed at some length. Numerous photographs illustrate the text.

STARRPUNKT UND VISKOSITÄT BITUMINOSER STOFFE. (Kohle, koks, teer, bd. 22.) By Hans Metzger. Wilhelm Knapp, Halle (Saale), 1930. Paper, 6 × 9 in., 59 pp., illus., diagrams, tables, 5.60 r.m.

The report of an investigation of methods for determining the viscosity of bituminous materials, which disclosed important new facts. An accurate method was developed for finding accurately the point of rigidity, and a means found for determining its relation to the drop-point. Methods are also given for testing the accuracy of experimental determinations of viscosity by mathematical methods.

STRENGTH OF MATERIALS, pt. 1; Elementary Theory and Problems. By S. Timoshenko. D. Van Nostrand Co., New York, 1930. Cloth, 6 × 9 in., 368 pp., diagrams, tables, $3.50.

The increasing size and cost of structures makes it ever more necessary for the designer to seek the design which will give the requisite strength and reliability with the greatest possible saving in material. The purpose of this book is to show ways of applying analytical methods toward these ends.

The present volume contains chiefly material usually given in the required courses in strength of materials. Attention is focused on the practical applications of the subject, the aim being to correlate studies of the strength of material and engineering design as fully as possible.

TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMERIQUES, vol. 7, parts 1–2. Compiled by Le Comité International. McGraw-Hill Book Co., New York; Gauthiers-Villars et Cie, Paris. Cloth, 9 × 11 in., 2 vols., 1896 pp., diagrams, $25 per set.

This annual summary of chemical, physical, and engineering facts reviews the new constants and numerical data that have appeared in any of the leading periodicals of the world. Because of its completeness and convenience, it is almost indis-

pensable to research workers in every line. It forms, also, a supplement to the International Critical Tables. The present volumes cover the years 1925 and 1926.

TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMÉRIQUES. TABLE DES MATIERES., Vols. 1–5; 1910–1922. Gauthier-Villars et Cie, Paris. McGraw-Hill Book Co., New York, 1930. Cloth, 9 × 11 in., 382 pp., $20.

The appearance of this index will be welcomed by all users of the Annual Tables of Constants. It contains analytic, alphabetic, and formula indexes to the material in the first five volumes of the Tables, thus making it a simple matter to find what is wanted, and making the set much more useful than it has been.

TECHNICAL ARTS AND SCIENCES OF THE ANCIENTS. By Albert Neuberger. Transactions by Henry L. Brose. Macmillan Co., New York, 1930. Cloth, 7 × 10 in., 518 pp., illus., $10.

A translation of Neuberger's "Die Technik des Altertums," which has for over a decade been widely read in Germany. The book brings together much information that is widely scattered, and presents it in understandable, interesting fashion. Numerous photographs and drawings illustrate the text. The whole field of mining, metallurgy, agriculture, ceramics, engineering, dyeing, etc., is treated.

TEXTBOOK OF SOUND. By A. B. Wood. Macmillan Co., New York, 1930. Cloth, 6 × 9 in., 519 pp., illus., diagrams, $6.50.

Covers a much wider field than that usually included under the word "sound," for Dr. Wood treats of vibrations of all frequencies, audible or otherwise. Side by side with the earlier work of Rayleigh and Lamb, he presents the new methods of investigation and the new theoretical developments that have arisen, and also calls attention to the many technical applications of today. He has produced an admirable textbook for university students, and also a convenient reference book for physicists and engineers.

UNTERSUCHUNGEN ÜBER DIE LEISTUNG UND DEN WIRKUNGSGRAD VON SANDSTRAHLDÜSEN. By Paul Nettmann and Heinrich Faber. (Fachausschuss für Anstrichtechnik, no. 5.) V.D.I. Verlag, Berlin, 1930. Paper, 8 × 12 in., 21 pp., illus., tables, 4 r.m.

Gives the results of experiments undertaken to determine the most efficient forms of nozzles, pressures, and kinds of sand for sandblasting machines.

VERTRIEBSGEMEINSCHAFTEN IN DER WERKZEUGMASCHINENINDUSTRIE. By Jos. Reindl. V.D.I. Verlag, Berlin, 1930. (Wirtschaftlicher Vetrieb, no. 6.) Paper, 6 × 8 in., 54 pp., 4 r.m.

Devoted to presenting the advantages of sales associations to manufacturers of machine tools. A plan for organizing and financing an association is included.

THE VOLATILITY OF MOTOR FUELS. By George Granger Brown. (Engineering Research Bulletin, no. 14.) University of Michigan, Department of Engineering Research, Ann Arbor, May 1930. Paper, 6 × 9 in., 299 pp., illus., diagrams, tables, $1.

Although the use of fuels of different volatility has been shown to have no noticeable effect on the power output or fuel consumption of motors operated under full throttle, this is not the case when motors operate at part throttle or when a warm motor is being accelerated. This bulletin gives the results of tests undertaken to determine the effect of variations in volatility upon the behavior of fuels under these conditions. The tests are reported in detail, with conclusions regarding the effect of fuel volatility upon engine performance.

WATER HEATING: a Reference Book on the Application of Gas for Water Heating, With Special Reference to Large Volume Water Users. American Gas Association, New York, 1930. Paper, 9 × 11 in., 130 pp., illus., diagrams, tables. Price not indicated.

A collection of practical information on the latest methods of applying gas to systems for supplying hot water in dwellings, hotels, offices, etc. The data include those usually wanted by engineers, architects, and builders. The book is sponsored by the American Gas Association.

WAVE-MECHANICS. By Arnold Sommerfeld. E. P. Dutton & Co., New York, 1930. Cloth, 6 × 9 in., 304 pp., $6.25.

Presented as a supplement to the author's well-known work, "Atomic Structure and Spectral Lines." Professor Sommerfeld here depicts recent developments in this field through the work of L. de Broglie, Heisenberg, Schroedinger, and Dirac, bringing into prominence what is of practical importance to the physicist. The author's attitude toward quantum mechanics and wave mechanics is presented clearly.

WAVE MECHANICS OF FREE ELECTRONS. By G. P. Thomson. McGraw-Hill Book Co., New York, 1930. Cloth, 6 × 9 in., 172 pp., illus., diagrams, portraits, tables, $2.50.

Contains a course of lectures delivered at Cornell University. The aim is to state the principles and application of the new wave mechanics, in so far as they concern electrons not forming part of an atom. The presentation is made with a minimum of mathematics.

DER WERKZEUGMASCHINEN-UND WERKZEUGBAU: FRITZ WERNER AKTIENGESELLSCHAFT, Berlin. By Hans Dominik. (Musterbetriebe Deutscher Wirtschaft, bd. 17). S. Hirzel, Berlin, 1930. Boards, 6 × 9 in., 80 pp., illus., graphs, forms. 2.75 r.m.

Describes the organization and methods of these well-known tool manufacturers, as an example of good practice in factory organization and management. The various departments are explained in detail, with emphasis on methods for controlling quality of products.

WHO'S WHO IN RAILROADING; United States, Canada, Mexico, Cuba. 1930 edition. Simmons-Boardman Publishing Co., New York, 1930. Cloth, 6 × 9 in., 579 pp., $8.50.

A reissue of the "Biographical Directory of Railway Officials of America" in an improved form. The biographies have been enlarged by the addition of personal information to the former purely official data, and the scope has been extended by the inclusion of individuals closely connected with railroading, although not railroad officials, such as manufacturers of equipment, economists, regulatory authorities, etc. These improvements add considerably to the value of the work.

WIND STRESSES IN BUILDINGS. By Robins Fleming. John Wiley & Sons, New York, 1930. Cloth, 6 × 9 in., 193 pp., illus., diagrams, tables, $3.50.

A summing up of the author's writings upon wind stresses during the past seventeen years. Beginning with a study of the wind, the book discusses hurricanes and tornadoes, wind pressure and wind velocity, wind stresses in steel mill buildings and many-storied buildings, and the design of details in tall buildings. Stress sheets and diagrams of the wind bracing of a fifty-three-story building are given. A chapter is added on earthquakes and earthquake resistance.

WOOD IN AIRCRAFT CONSTRUCTION: Supply, Suitability, Handling, Fabrication, Design. By George W. Trayer. National Lumber Manufacturers Assn., Washington, D. C., 1930. Cloth, 6 × 9 in., 276 pp., illus., tables, $2.50.

Aims to present the information upon the structural properties of wood which is wanted by designers and builders of airplanes. The selection of woods, methods of seasoning, bending, and gluing, veneer and plywood, the design and calculation of airplane elements, etc., are discussed, on the basis of the investigations made by the Forest Products Laboratory.

Synopses of A.S.M.E. Transactions Papers

THE papers abstracted on this and following pages appear in the current issues of Applied Mechanics, Hydraulics, and Printing Industries sections of A.S.M.E. Transactions. These sections have been sent to all who registered in the similarly named Divisions. Other sections are in the course of preparation and will be announced when completed, in later issues of "Mechanical Engineering."

APPLIED MECHANICS PAPERS

THE RADIALLY TAPERED DISK SPRING. By W. A. Brecht and A. M. Wahl. [Paper No. APM-52-4]

In this paper disk springs, both flat and dished, having radially tapered cross-sections are considered. The advantages of such springs are discussed. Equations are developed by approximate and more exact methods for calculating the strength and flexibility of such springs. The theoretical work is checked up by numerous tests, including both strain and deflection measurements. It is concluded that springs of this type may be of advantage in certain applications.

PERFORMANCE OF OIL-RING BEARINGS. By G. B. Karelitz. [Paper No. APM-52-5]

This paper comprises notes on the performance of oil-ring-lubricated bearings. The safety of the bearing determined by the minimum oil-film thickness is discussed; a diagram for computation of this value is given. The end leakage and the amounts of oil supplied by oil rings are shown, and the mechanism of operation of oil rings is described. The friction losses and the heat dissipation in oil-ring bearings are estimated, and a way to predetermine the temperature rise of a bearing is indicated.

POWER APPLICATION TO OSCILLATING AXLES. By Alain Madlé. [Paper No. APM-52-6]

In this paper a type of axle is described in which the load is not carried by the wheel center but is suspended at the end of an arm which is permitted to swing like a pendulum about the wheel center. This mechanism is called a differential drive, and its application to motor-driven vehicles is described. The forces acting in the mechanism and the conditions necessary for an equilibrium of forces are worked out mathematically, and a comparison is given of starting motor trucks by two systems: first, when equipped with an oscillating axle with differential drive, and second, with the usual method of drive.

By means of the differential drive it is claimed that torque can be applied momentarily to the wheel without turning it, and that an elastic connection is provided between the power line and the wheel which cushions torsional impacts. Whenever there are changes in the running conditions of the vehicle, fluctuations of energy between the wheel assembly and the vehicle body take place. The reaction forces of these fluctuations provide an increased pressure against the ground, an additional accelerating force, and a greater retarding force.

CRANKLESS RECIPROCATING MACHINES. By Anthony G. M. Michell. [Paper No. APM-52-7]

The general features and properties of the crankless type of reciprocating machine, as compared with the crank-connecting-rod type, are described and illustrated. A few varieties of the crankless type are briefly described, including the author's slant-slipper form of the mechanism. The limitations of the crank type are pointed out, and it is suggested that mechanical science is due to supply a type of machine for various present and probable future applications not efficiently served by either purely rotary machines or reciprocating machines of the crank type. A case is presented for the crankless type as satisfying this need.

ENGINEERING COMPUTATIONS FOR AIR AND GASES. By Sanford A. Moss and Chester W. Smith. [Paper No. APM-52-8]

In this paper the authors give methods of making the usual engineering computations for adiabatic compression, expansion, flow through measuring nozzles, and similar work concerned with the thermodynamic properties of air and gases, in the minimum amount of time and with the greatest accuracy possible with engineering methods. The theoretical formulas needed are included, together with extensive tables for use in computation.

ELASTIC AND INELASTIC BEHAVIOR IN SPRING MATERIALS. Progress Report No. 5 of the A.S.M.E. Special Research Committee on Mechanical Springs (Technological). By M. F. Sayre. [Paper No. APM-52-9]

Since the last progress report was published, work on the behavior of spring metals in direct stress has been done which has clarified several points which were then uncertain, and which has opened several new points regarding elastic behavior. In particular, the experimental results suggest the following conclusions:

1 Occasional overloads in tension up to the elastic limit of spring steel or phosphor bronze do not affect its elastic properties.

2 For these purposes, the elastic limit must not be taken as synonymous with the proportional limit. In last year's report both an upper and a lower proportional limit were given, with two moduli of elasticity for the different portions of the stress-strain curve.

3 For stress ranges in tension within the elastic limit of the material, the amount of hysteresis, the "backlash" in elongation between increasing and decreasing loads, increases with the load range, varying with load as some power between the square and cube.

4 The true shape of the hysteresis loop is apparently more or less like a string-bean pod rather than an ellipse. It is eccentrically pointed at each end, and often (depending on the relative height and width of the loop) may have a slight in-curve on the lower side.

HYDRAULIC PAPERS

DETERMINATION OF THE ACTUAL THEORETICAL HEAD OF A CENTRIFUGAL PUMP. By Michael D. Aisenstein. [Paper No. HYD-52-3]

The purpose of this paper is to show how the theoretical head of a centrifugal pump, as calculated by means of the classical theory, can be made to agree with experience. The study presented is based upon the actual performance of a large number of centrifugal pumps.

MECHANICS OF HYDRAULIC-TURBINE PRESSURE REGULATION. By Arnold Pfau. [Paper No. HYD-52-4]

Problems of pressure control or the pressure variations resulting from the action of the governor complicate calculations of hydraulic turbines. This paper describes mechanical means whereby desired field results can be obtained under existing conditions of operation and of pipe-line characteristics. Calculations, formulas, and examples of speed and pressure control take up such points as closing gates, passing through position of static balance of turbine gates, formulas for speed regulation, effect of pressure variations on speed, and calculations of pressure rises in pipe lines.

REPORT OF COMMITTEE ON SURVEY OF HYDRAULIC RESEARCH, OF THE HYDRAULIC DIVISION. [Paper No. HYD-52-5]

This report (1) presents 24 hydraulic problems for research suggested by members of the committee as coming from themselves and from those who submitted answers to questionnaires; (2) extensive data on researches being conducted in Europe on general hydraulics, hydraulic turbines, and centrifugal pumps; and (3) research studies being carried out by American water-power companies, consulting engineers, and by hydraulic laboratories.

POWER—STEAM OR HYDRO, OR BOTH. By Wm. W. Tefft. [Paper No. HYD-52-6]

Emphasis is placed on the necessity of including all pertinent factors in a comparison of steam with hydro power, drawing attention to the fact that any conclusions based upon a part of these factors will be erroneous, misleading, and valueless. In considering the various factors that go to make up the final conclusion, attention is called to the superiority of steam power where need for power is immediate, where the more profitable hydro sites have already been developed, and where the actual load factor is very high. It is also made clear that hydro power is superior in reliability and as reserve capacity, and can operated to advantage at a much lower load factor than can steam. It might be said that the paper deals largely with load factor. Curves based upon a large number of developments in each case indicate that usually for 60 per cent load factor or less the hydro plants are superior, the statement being made that no steam plant can now be built for 25 per cent load factor that will produce current for 1 cent per kw-hr., but there are many water-power plants, most of them in fact, that can do this.

It is concluded that there is ample proof that a power system combining both steam and hydro plants can generate power cheaper than either kind of prime mover.

PRINTING INDUSTRIES PAPERS

PRODUCTION ENGINEERING IN THE PRINTING PLANT, A FACTOR THAT CAN BE MERCHANDISED. By H. R. Lewis. [Paper No. PI-52-1]

As a result of an analysis of plant, equipment, personnel, costs, and merchandising methods the company with which the author is connected specializes on the manufacture of hard-bound books. A straight line system of production was worked out which made it necessary to enlarge various departments. The author tells of the changes that were made and the result accomplished.

THE MUNDER SYSTEM FOR PAPER SELECTION. By Norman T. A. Munder. [Paper No. PI-52-2]

There are many makers of paper, and each one sends out sample books. These books are generally addressed to some individual in a printing or advertising house and become his property. The Munder system for paper selection provides a cabinet containing the paper-sample books of 54 paper makers. These books, over 400 in number, are indexed by uses, qualities, and prices, and provide an easy reference for all in an office who are interested in the selection of paper for various uses.

PRINTING-PLANT OPERATION WITHOUT ALIBIS; IS IT POSSIBLE? By Hadar Ortman. [Paper No. PI-52-3]

The author describes printing-plant operation as "the industry of alibis," and he asserts that it is easy to designate duties and to prepare specifications and instructions so that responsibility may be placed where it belongs and mistakes may be properly traced and their repetition prevented. He summarizes the principles of successful management and operation under eight heads.

PAPER AND PRINTING. By E. O. Reed. [Paper No. PI-52-4]

Paper must have certain physical properties to be suitable for use with the different printing processes. Technical specifications for paper and paper testing have been developed to secure proper quality for a specific purpose, but it is not possible to standardize paper made by all mills on a few physical and chemical tests. Such factors as appearance, color, feel, finish, formation, or printability are distinctive mill characteristics. The qualities discussed by the author are paper finish, moisture content, and relationship to printing inks.

PERMANENCE STANDARDS FOR PRINTING AND WRITING PAPERS. By B. W. Scribner. [Paper No. PI-52-5]

Experience with printed and written records has shown the necessity of having adequate standards of permanency for selection of record papers. Sufficient technical knowledge is available for the formulation of such standards, and there is sufficient interest in their establishment to make such a project feasible. This paper outlines the available information on the permanence of papers and indicates how it may be applied to formulate definite technical specifications for permanence qualities. The history of paper making is traced to show its relation to the deterioration of papers, and the causes of deterioration as shown by the history of papers and by research are outlined. From this information is shown the necessity of dependence on performance and purity tests for selection of papers. The strength of paper and its purity, both cellulosic and non-cellulosic, are the important factors in its aging quality. A classification based on strength and purity is suggested which places papers in the following four groups: (1) Papers of absolute permanence, (2) papers having a minimum life of 100 years, (3) papers having a minimum life of 50 years, (4) papers for temporary use.

TECHNICAL SPECIFICATIONS FOR PAPER USERS. By B. L. Wehmhoff. [Paper No. PI-52-6]

This paper is a discussion of the use of technical specifications in the purchase of paper for use in the printing industry. Data are given to show the wide variations in quality between papers sold under the same designation. The experience of the Government Printing Office during the past 20 years is cited as an example of the practicability and value of technical specifications in the purchase of 50,000,000 pounds of paper annually. Benefits to be derived by the printer by a standardization of grades of paper and their purchase under technical specifications are described, as well as the benefits which would result to the manufacturers. Since standardization of grades of paper would be of considerable assistance in the purchase of paper under technical specifications by small consumers, reports from committees of the American Pulp and Paper Association are quoted to show the present attitude of part of the paper industry toward standardization.

NOTE: Those who have not registered in the A.S.M.E. Applied Mechanics, Hydraulic, and Printing Industries Divisions whose papers are abstracted on this and the previous page, and who desire copies of any of these papers, may obtain them by using the form given below.

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THE ENGINEERING INDEX SERVICE furnishes to its subscribers a Weekly Card Index of references to the periodical literature of the world covering every phase of engineering activity, including Aeronautic, Chemical, Civil, Electrical, Management, Mechanical, Mining and Metallurgical, Naval and Marine, Railway, etc. Of the many items of particular interest to mechanical engineers a few are selected for presentation each month in this section of "Mechanical Engineering." In operating The Engineering Index Service, The American Society of Mechanical Engineers makes available the information contained in the more than 1800 technical publications received by the Engineering Societies Library (New York), thus bringing the great resources of that library to the entire engineering profession. At the end of the year all references issued by the Service are published in book form, this annual volume being known as The Engineering Index.

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ACCELEROMETERS

Principles and Design. Direct Measurement of Acceleration and Retardation of Motor Vehicles (Die unmittelbare Messung der Beschleunigung und der Bremsverzoegerung von Fahrzeugen), Deiters. Automobiltechnische Zeit. (Berlin), vol. 33, no. 29, Oct. 1930, pp. 702–703, 6 figs. Illustrated principles and design of apparatus mounted on running board of automobile; pendulum damped by vane registers changes in speed; method of measuring changes of speed in aircraft.

AIR COMPRESSORS

Installation. Selecting and Installing Air Compressors, H. L. Kauffman. Machy. (N. Y.), vol. 37, no. 3, Nov. 1930, pp. 165–167. Principles to be applied in buying air compressors and those that govern purchase of equipment; capacity of 2-stage compressors; important points concerning intercooler; mechanical, volumetric, and compression efficiency.

AIR PREHEATERS

Recent Developments in. Recent Developments in Air Preheaters. World Power (Lond.), vol. 14, no. 82, Oct. 1930, pp. 350 and 352, 4 figs. Tabulation gives typical comparison between boiler-house practice today and ten years ago; design features of Howden-Ljungström preheater.

AIRPLANE ENGINES

Argus. Argus Airplane Engine As 8 (Der Argus-Flugmotor As 8), W. Kamm. V.D.I. Zeit. (Berlin), vol. 74, no. 41, Oct. 11, 1930, pp. 1409–1412, 6 figs. Design and specifications of most successful engine in 1930 European circuit contest; inverted 4-cylinder inline air-cooled engine of 80 hp. continuous output, of 120 by 130 mm. bore and stroke, weighing 112 kg.; graphs illustrate performance and torsional vibration characteristics.

Diesel. 100-Hp. Clerget Heavy-Oil Engine (Le moteur Clerget 100 Hp. à huile lourde), Léglise. Aéronautique (Paris), vol. 12, no. 138, Nov. 1930, pp. 391–396, 16 figs. Principles of design and operation of radial air-cooled 9-cylinder engine of 120 by 130 mm. bore and stroke developing 100 hp. at 1800 r.p.m. and weighing 228 kg.; sketches illustrate details of fuel-injection system.

Silencing. The Road to Noiseless Flight, J. H. Geisse. West. Flying, vol. 8, no. 5, Nov. 1930, pp. 42–44, 2 figs. Progress in reducing engine noises by absorption and elimination at source; mufflers to absorb sound; new type Comet exhaust collector ring; elimination of piston slap by use of new aluminum alloy and nickel iron with similar expansion coefficients; silencing of valve mechanism and tappet noises.

AIRPLANES

Autogiros. See AUTOGIROS.

Metal Construction. Aircraft Rib and Spar Construction. Machy. (Lond.), vol. 37, no. 941, Oct. 23, 1930, pp. 97–102, 15 figs. Metals and equipment employed by Bristol Aeroplane Co. Data on tolerances; rib assembly; flange bending rolls and bending tools for cross-bracing; spar testing machine; shaping corrugated strip steel; combined clamp and drill jig, hand punch and riveting tools; tools used in developing spar post.

Noise Elimination. The Measurement of Noise. Engineer (Lond.), vol. 150, no. 3899, Oct. 3, 1930, pp. 371–372. Editorial comment on work of subcommittee of Aeronautical Research Committee appointed to study aircraft noise; charged to arrange program of research relating to reduction of noise, not only as it manifests itself inside cabins of passenger-carrying machines, but as heard on ground from machine passing overhead; Committee has produced instrument, apparently successful for measuring noises; device of audiometer type has been calibrated in absolute acoustical units, namely in "decibals" of which 130 cover range of sensation of ear.

Propellers. Full Scale Wind Tunnel Tests of a Propeller With the Diameter Changes by Cutting Off the Blade Tips, D. H. Wood. Nat. Advisory Committee Aeronautics—Report no. 351, 1930, 25 pp., 26 figs. Diameter of standard 10-ft. metal propeller was changed successively to 9 ft. 6 in., 9 ft., 8 ft. 6 in., and 8 ft. in propeller research tunnel of National Advisory Committee for Aeronautics using open-cockpit fuselage and D-12 engine; small loss in propulsive efficiency is indicated; examples showing application of results to practical problems.

Seaplanes. See SEAPLANES.

Spinning Characteristics. Airplane Tail-Spins Analyzed, H. A. Sutton. Soc. Automotive Engrs.—Jl., vol. 27, no. 5, Nov. 1930, pp. 573–577, 3 figs. Report on test with two biplanes differing greatly in wing-cellule arrangement; effects on spinning characteristics of varying center-of-gravity location, mass distribution, control position and engine power; rearward weight added behind wings delays recovery from spin.

Spinning Experiments, P. E. Hovgard. Soc. Automotive Engrs.—Jl., vol. 27, no. 5, Nov 1930, pp. 571–572. Spinning tests conducted at Keystone plant to find easy cure-all for flat spins; effect of shifting ballast and center of gravity, decallage and washout on stability; location of axis of rotation.

The Cause and Prevention of Spinning, G. P. Peed, Jr. Soc. Automotive Engrs.—Jl., vol. 27, no. 5, Nov. 1930, pp. 566–571, 3 figs. Methods of preventing flat spins with aid of mathematical formulas; unfavorable progression of moments is not in itself sufficient to cause spin although moments are very large factor in giving airplane its initial flat turn; location of center of gravity exerts very little effect on spinning characteristics of airplane; application of findings to Eagle Rock Bullet.

AIRSHIPS

Akron, Ohio, Plant. Erecting the World's Largest Roof, W. J. Watson. Civil Eng. (N. Y.), vol. 1, no. 2, Nov. 1930, pp. 71–76, 1 fig. Data on modern airships and airship docks in Europe and America; design of airship factory and dock for Goodyear Zeppelin Corp., Akron, Ohio; length is 1175 ft., width 325 ft., and height 197½ ft. from center of lower to center of top pins; analysis of arch stresses, deflection, expansion and contraction, roof covering, wind pressures, etc.; features of orange peel doors having leaves weighing about 600 tons each; fire protection; helium storage. Abstract of paper read before Am. Soc. Civil Engrs.

ALIGNMENT CHARTS

Construction. General Method for Evaluation of Graphical Computation Chart, With Special Reference to Alignment Charts (Allgemeins Verfahren zum Entwerfen von graphischen Rechentafeln, insbesondere von Fluchtlinientafeln), A. Fischer. V.D.I. Zeit. (Berlin), vol. 74, no. 44, Nov. 1, 1930, pp. 1515–1516, 2 figs. Principles of alignment-chart construction, with numerical examples of their application in hydraulic and structural engineering.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Bronze. See BRONZE.

Copper. See COPPER ALLOYS.

Die-Casting. See DIE CASTING.

Non-Ferrous, Hardness of. Hardness of Metal Alloys at Various Temperatures (Die Haerte der Metallegierungen bei verschiedenen Temperaturen), W. Schischokin and W. Agejewa. Zeit. fuer anorganische und allgemeine Chemie (Leipzig), vol. 193, no. 3, Oct. 21, 1930, pp. 237–244, 10 figs. Report from Leningrad Polytechnic Institute on experimental study of hardness of alloys: bismuth-tin, bismuth-cadmium, lead-cadmium, tin-cadmium, lead-tin, tin-zinc, and zinc-cadmium for temperatures up to 200 deg. cent.

ALUMINUM

Machining. New Developments in Machining Aluminum, R. L. Templin. Machy. (N. Y.), vol. 37, no. 3, Nov. 1930, pp. 214–216, 2 figs. Methods recommended for machining aluminum and aluminum alloys, based both on laboratory experiments and on everyday shop practice; sketches show tool bits made from round stock, ground for machining aluminum, as applied to tool-holders and milling cutters. Abstract of paper presented before Soc. Automotive Engrs., Oct. 7–8, 1930.

ALUMINUM ALLOYS

Automotive. Light Metal Construction in Transportation Industry (Leichtmetallbau im Verkehrswesen), F. Gentzcke. Hauszeitschrift der V.A.W. u.d. Erftwerk A.G. fuer Aluminium (Berlin), no. 6–7, Sept.-Oct. 1930, pp. 135–157, 31 figs. Properties of light metals and their effect on design; machining, heat treatment and surface protection; economical benefits derived from application in different fields of transportation.

Castings, Corrosion of. Corrosion of Aluminum-Alloy Castings (Ueber die Korrosion von Aluminum-Gusslegierungen), R. Sterner-Rainer Zeit. fuer Metallkunde (Berlin), vol. 22, no. 10, Oct. 1930, pp. 357–361 and (discussion), 361–362, 6 figs. Effect of air and water under different conditions; influence of metal admixtures; critical discussion of different commercial alloys; corrosive action of chemical agents; paints and protective coatings.

AMMONIA

Properties. Physical Properties of Anhydrous Ammonia, B. C. Oldham. Ice and Refrig., vol. 79, no. 4, Oct. 1930, p. 274. With development of quick freezing and other low-temperature applications of refrigeration, demand has arisen for accurate data on physical properties of ammonia at temperatures lower than those hitherto in general use; table of physical properties of anhydrous ammonia; extension of saturated vapor tables down to minus 105 deg. fahr.

AMMONIA COMPRESSORS

Compound. Compound Ammonia Compressor (Totrins Ammoniak Kompressor). P. A. Halberg. Teknisk Tidskrift (Stockholm), vol. 60, no. 42, Oct. 18, 1930 (Mekanik), pp. 134–138, 6 figs. Construction and operation of 815,000-cal. and 600,000-cal. compound compressors and also 1.3-million cal., single-cylinder compressor in manufacturing plant in Denmark; advantages of compound compressors.

ASH HANDLING

Pneumatic. Pneumatic Ash-Removal Wagon. Engineering (Lond.), vol. 130, no. 3380, Oct. 24, 1930, p. 537. Equipment manufactured by Allen Air Appliance Co., New York, consists essentially of two motor cars, one of which carries multi-stage exhauster and other cylindrical steel container, into which ashes can be drawn direct from ashpit in building, through either permanent or temporary pipe system.

AUTOGIROS

Advantages of. Flying an Autogiro, J. G. Ray. Airway Age, vol. 11, no. 11, Nov. 1930, pp. 1427–1429, 3 figs. Advantages of autogiro with regard to piloting, particularly in climbing and descent; specifications and performance data of PCA-2, three-place machine powered with Wright Whirlwind 225; high speed, 120 m.p.h.; minimum flying speed, 20 m.p.h.; landing speed, 0 m.p.h.

AUTOMOBILE ENGINES

Crankshafts. Crankshaft Machining Requires Diversity of Operations, A. F. Denham. Automotive Industries, vol. 63, no. 17, Oct. 25, 1930, pp. 609–618, 10 figs. Production methods and equipment and their relation to basic design of crankshaft are illustrated by actual practice in various automobile plants; dynamic and static balance; centering of crankshaft; finishing operation, grinding, balancing and inspection.

AUTOMOBILE MANUFACTURE

Heat Treatment. Heat Treatment of Automotive Steels, J. W. Urquhart. Heat Treating and Forging, vol. 16, no. 10, Oct. 1930, pp. 1295–1299, 2 figs. Composition and properties of steel for principal parts of automobile engine and frame; high-grade axle, crankshaft and gear steels.

Continuous Heat-Treating, C. L. Bockus. Factory and Indus. Mgmt., vol. 80, no. 5, Nov. 1930, pp. 959–960, 2 figs. Method used by Studebaker Corporation, South Bend, Ind.; saves $15,000 in direct labor; insures better quality, conserves floor space; leads to better working conditions.

AUTOMOBILES

Design. Motor Car Tendencies Abroad. Engineer (Lond.), vol. 150, no. 3901, Oct. 17, 1930, pp. 429–430. That automobile construction continues in state of evolution was revealed at show held in Paris; question of price sets limit to technical progress in French industry; limitations imposed upon technical progress by limited means of buyers; six-cylinder engine has not achieved popularity expected, because it is beyond means of those who seek economy; there is widening gap on Continent between 4-cylinder popular car and more powerful touring vehicle; 12-cylinder engine has been reintroduced by German and other makers with new features.

The Future Trend of Automobile Design, H. Austin. Automobile Engr. (Lond.), vol. 20, no. 272, Oct. 1930, pp. 386–388. Critical review of present state of automobile design and suggestions for improving economy, riding qualities and performance; reduction of weight and elimination of parts is desirable.

Trend of 1931 (L'Ecole de 1931), G. Faroux Vie Automobile (Paris), vol. 26, no. 954, Sept. 25, 1930, pp. 337–344, 11 figs. Critical review of latest trend in design; development of light alloys; prospects of heavy-oil engine; down-draft carburation; improved suspension method; remote control of shock absorbers.

Performance Testing. Motor-Vehicle Performance Indicating and Recording Devices, C. W. Stocks. Soc. Automotive Engrs.—J., vol. 27, no. 5, Nov. 1930, pp. 529–540, 20 figs. Several types of recording devices now available are analyzed and descriptions given which illustrate benefits derived from their usage; reliability of speedometers; speed-indicating or mileage-recording devices; rating of engine performance by engine revolutions; Ohmer-Kienzle vibracorder, without drive; Pittsburgh truck recorder; autograph recorder; Hasler Tel recorder.

Springs and Suspension. Suspension of Modern Car (La suspension sur la voiture moderne), R. E. Faroux. Vie Automobile (Paris), vol. 26, nos. 954 and 955, Sept. 25, 1930, pp. 368–370 and Oct. 10, pp. 557–561, 13 figs. Review of fundamental problems; methods of spring arrangement, effect of tire, function of shock absorbers; relative merits of suspension methods used by Cottin-Desgouttes, Bucciali, Sensaud de Lavaud and Lancia-Dilambda.

AUTOMOTIVE FUELS

Detonation. The Influence of Engine Conditions on the Anti-Knock Rating of Motor Fuels, R. Standsfield and F. B. Thole. Engineering (Lond.), vol. 130, nos. 3378 and 3380, Oct. 10, 1930, pp. 478–480, and Oct. 24, pp. 512–514, 7 figs. In addition to study of jacket-temperature effects over wide range, tests have been made to determine influence of different degrees of inlet air heating; variation in throttle opening; variation in ignition advance; effect of such changes of humidity as are likely to be met in practice was also investigated.

[See also DIESEL ENGINES, Fuels.]

AVIGATION

Calculating Instrument. New Navigation Instrument: Cluzel Calculator (Un nouvel instrument de navigation: le calculateur de Cluzel). Aéronautique (Paris), vol. 12, no. 138, Nov. 1930, pp. 401–402, 4 figs. Working principle and design of instrument for determining position by means of pantograph arrangement.

B

BALANCING MACHINES

Design and Operation. Balancing Technique and Vibration Elimination in Engine Production (Auswuchttechnik und Schwingungsbekaempfung im Motorenbau), W. Spaeth. Automobiltechnische Zeit. (Berlin), vol. 33, no. 28, Oct. 10, 1930, pp. 671–675, 8 figs. Principles and operation of various types of balancing machines; Losenhausen machine with electric quick balancing device; merits of high-speed and low-speed balancing machines.

The Balancing of Machinery, C. N. Fletcher. Mech. World (Manchester), vol. 68, no. 2285, Oct. 17, 1930, pp. 367–370, 9 figs. Principles of design, purpose and operation of different types of balancing machines, Martin static balancing machine, Avery static balancing machine, Hofmann-Kunze static balancing machine Umbrella type of static balancing equipment for balancing flywheels, rotors and crankshafts.

BINARY VAPOR SYSTEM

Koenemann. German Scientist Proposes Binary Chemical Cycle for Power Generation. Power, vol. 72, no. 18, Oct. 28, 1930, pp. 681–683, 4 figs. E. Koenemann predicts 30 per cent fuel saving and 41 per cent cooling-water saving by plant utilizing ammonia vapor in upper cycle and steam in lower; ammonia gas for turbine operation is released from (and later reabsorbed by) water-free melted zinc-chloride ammoniacate; semi-schematic elevation of Koenemann plant with reheating steam cycle.

Two-Fluid Cycles for Power Plants. Engineer (Lond.), vol. 150, no. 3902, Oct. 24, 1930, p. 458. Editorial discussion of Koenemann process described by him in paper before World Power Conference, Berlin; process requires boiler to contain mixture of simple and double ammoniates of zinc chloride instead of water; boiler works at 480 deg. cent., at which temperature substances are partly decomposed and ammonia driven off at pressure of 100 lb. per sq. in.; up to present, scheme is perhaps most hopeful of success; it is well-considered attempt to realize principle which will almost certainly dominate thermal power development in future.

BLAST-FURNACE GAS

Cleaning. A Recording Dust Concentration Meter for Blast Furnace Gas, A. W. Simon. Blast Furnace and Steel Plant, vol. 18, no. 11, Nov. 1930, pp. 1686–1689, and 1700, 11 figs. Design and performance of instrument based on principle that amount of light absorbed, and therefore amount of light transmitted, by column of dust-laden gas depends on dust content of gas; apparatus for determining variations of light transmitted by column of dust-laden gas with distance traversed by beam; typical charts of instantaneous dust content obtained on blast-furnace gas mains. Paper presented before Am. Iron and Steel Inst.

BLOWERS

Blast-Furnace. Turbo-Blowers in a European Plant. Blast Furnace and Steel Plant, vol 18, no. 11, Nov. 1930, pp. 1715 and 1718, 2 figs. Two blowers installed at Krupp plant; capacity of each 111,000 c.f.m. at 21½ lb. per sq. in. G., and 92,000 c.f.m. at 32 lb. G.; maximum speed of 3000 r.p.m.

BOILERS

Design. Boiler Calculation and the It-Diagram (Dampfkesselberechnung und It-Diagramm), F. Michel. Feuerungstechnik (Leipzig), vol. 18, nos. 17–18 and 19–20, Sept. 15, 1930, pp. 169–171 and Oct. 15, pp. 191–194, 2 figs. Importance of boiler calculation is emphasized; requisites of modern calculating method which necessitates use of heat content—temperature diagram termed It-diagram, based on 1 kg. of fuel.

Boilers and Furnaces (Kessel und Feuerungen), F. Beuthner. Archiv fuer Waermewirtschaft (Berlin), vol. 11, no. 11, Nov. 1930, pp. 365–366. Lignite and bituminous coal grates; pulverized coal firing; radiation phenomena in furnace; ash removal; furnace cooling surfaces; increasing boiler efficiency; new types of boilers; boilers for peak-load plants; high-pressure boilers, heat-resisting materials automatic boiler control; feedwater treatment, etc. Paper read before World Power Conference, Berlin.

Electric. Electric-Boiler and Heat-Accumulator Installation. Engineering (Lond.), vol. 130, no. 3378, Oct. 10, 1930, pp. 460–461, 7 figs. Three Mascarini boilers with total capacity of 4500 lb. of steam per hr. have been installed at Buttercup poultry farm, near Edinburgh, to supply steam for heating brooder rooms; as further precaution against failure of supply, boilers normally deliver steam to Ruths accumulator; steam supply from accumulator passes to radiators at pressure of 3 to 5 lb. per sq. in. and brooder rooms are heated by warm air circulated over radiators by means of fans.

Firing, Pulverized Coal vs. Stoker. A Comparison of Pulverized Coal and Stokers in Industrial Plants, S. M. Green. Power, vol. 72, no. 19, Nov. 4, 1930, pp. 722–725, 4 figs. Public-service plants have to meet essentially same requirements, and they vary principally in size; industrial plants, however, must meet widely different conditions, not only in many different industries but also within one industry; paper relates to boilers and their auxiliary equipment as applied to industrial uses only and includes actual installation costs and manufacturer's performance guarantees in two comparative plants, one with stokers and other with pulverizers.

High-Pressure. Experience With High-Pressure Boilers in Central Europe, A. Weisselberg. Power, vol. 72, nos. 16 and 17, Oct. 14 and 21, 1930, pp. 600–603, 6 figs., and 644–648, 6 figs. Oct. 14: Observations made at number of high-pressure plants. Oct. 21: Comparison of results being obtained with Benson and Schmidt boilers at two high-pressure installations on continent; diagram showing automatic control of steam and feedwater of high-pressure boiler.

Manufacture—Great Britain. High-Pressure Water-tube Boiler Developments at Renfrew. Engineer (Lond.), vol. 150, no. 3899, Oct. 3, 1930, pp. 366–368, 7 figs. On Sept. 25th, party of over 90 engineers accepted invitation of Babcock and Wilcox, to inspect new boiler developments at firm's Renfrew factory; principal features of plants inspected by members of party; high-pressure boiler making; pulverized-fuel boiler test house; high-pressure boilers on Clyde turbine steamer "King George V."

Steam-Heating. Value of Coke Texture for Central Heating Plant (Die Bedeutung der Korngroesse fuer Zentralheizungskoks), Heitmann. Gesundheits Ingenieur (Munich), vol. 53, no. 35, Aug. 30, 1930, pp. 529–536, 10 figs. Detailed report on results of tests undertaken by Gebr. Koerting A.G., on effect of grain size of coke used on efficiency, speed of combustion, fuel costs, etc.; relation between coke texture and duration of combustion.

Water Circulation in. Recent Water-Circulation Problems in Boiler Practice (Nuere Wasserumlaufprobleme im Kesselbau), K. Cleve. Archiv fuer Waermewirtschaft (Berlin), vol. 11, no. 11, Nov. 1930, pp. 359–363, 8 figs. Study of flow of water in cut-off tubes, or tubes which cut off a steam forming line of tubes by tube which is slightly or not at all heated; water can flow upward or downward depending upon dimensions; significance of tubes with intermittent water flow for safety of water-tube boilers; calculation of minimum speed in downcomer to insure freedom from steam formation and maximum speed in relation to boiler design.

Water Circulation in Boilers (Der Wasserumlauf in Dampfkesseln), O. Berner and K. Baum. Waerme (Berlin), vol. 53, nos. 39 and 41, Sept. 27, 1930, pp. 732–735, and Oct. 11, pp. 778–783, 14 figs. Criticism of more recent circulation tests and their significance for practical boiler construction.

Welding. Advocates Electric Welding of Boilers. Elec. World, vol. 96, no. 15, Oct. 11, 1930, pp. 694–696, 8 figs. Babcock & Wilcox Co. bases recommendation on several hundred tests; declares code should recognize electric welding; characteristics of welds determined by x-ray and electromagnetic methods; characteristics of B. & W. fusion weld are listed.

Recent Welding Practice of Boilers, Steam and Pressure Vessels (Neuere Arbeiten im Schweissen der Dampfkessel, Dampfgefaesse und Druckbehaelter), E. Hoehn. Elektroschweissung (Braunschweig), no. 10, Oct. 1930, pp. 193–196, 10 figs. Boilers and pressure vessel which are usually electrically welded are discussed; tabular data on boilers welded in Switzerland of which seams are reinforced by riveting; examples of recent work; stretch curves.

Scientific Control in Welding of Boiler Drums. E. C. Hutchinson. Power, vol. 72, no. 15, Oct. 7, 1930, pp. 562–566, 19 figs.; see also anonymous similar article in Power Plant Eng., vol. 34, no. 20, Oct. 15, 1930, pp. 1183–1184, 4 figs. Precision and organized method are necessary precedents to acceptance of fusion welding for boiler drums; test analysis and results; account of visit to Barberton works of Babcock & Wilcox Co.

BRONZE

Special Bronzes. Special Bronzes (Sonder-Bronzen), W. Claus. Metallboerse (Berlin), vol. 20, nos. 80 and 82, Oct. 4, 1930, pp. 2217–2218, and Oct. 11, pp. 2274–2276, 6 figs. Oct. 4: Iron, chromium, tungsten, vanadium, and molybdenum bronzes. Oct. 11: Beryllium bronzes; results of tension, bending and notch hardness tests.

C

CARBON DIOXIDE

Solid. Solid Carbon Dioxide. Ice and Refrig., vol. 79, no. 5, Nov. 1930, pp. 405–406. Recent letter circular issued by Bureau of Standards of United States Department of Commerce containing data on solid carbon dioxide; density; temperature; vapor pressure; latent heat of sublimation; latent heat of fusion; specific heats at low temperature; uses.

CARS

Aluminum. Results Obtained in Aluminum Construction of Main-Line and Street-Railway Cars (Résultats obtenus dans la construction en aluminium des voitures de chemins de fer et de tramways), P. Haenni. Genie Civil (Paris), vol. 97, no. 15, Oct. 11, 1930, pp. 363–365, 1 fig. Use of aluminum alloys in construction of car frames with special reference to Swiss experiences.

Dynamometer. New Dynamometer Car, Great Indian Peninsula Railway. Ry. Gaz. (Lond.), vol. 53, no. 15, Oct. 10, 1930, pp. 468–470, 3 figs. Car equipped with latest instruments and apparatus, manufactured by Metropolitan-Cammell Carriage, Wagon & Finance Co.; underframe details; apparatus and measuring instruments; measuring work at drawbar. See also editorial comment on p. 455.

Passenger, Draft Gears for. Alma Draft Gear Tested in Passenger Service. Ry. Age, vol. 89, no. 16, Oct. 18, 1930, pp. 800–803, 7 figs. Continuous elastic draft and bufling gear to which rear car body is elastically attached through suitable cushioning; springs have been subjected to service tests on number of passenger cars in United States for past year and half; construction and operation of Alma gear; graphic comparison of shocks recorded in starting and stopping tests.

CASE HARDENING

Cyanide Bath for. The Structure of the Case in Cyanide-Hardened Steel. W. Henninger and H. Jurich. Eng. Progress (Berlin), vol. 11, no. 11, Nov. 1930, pp. 297–298, 4 figs. It has been found possible by etching with hot concentrated sodium picrate solution, to render presence of eutectoid and needles visible in straight low-carbon steel treated in cyanide bath for five hours with following slow cooling; carburization taking place in cyanide bath is remarkable in that in marginal structure well-developed cementite veins and laminal pearlite are visible.

CHROMIUM-NICKEL STEEL

Present Status. High-Chromium Alloy Steels, Their Present Status, E. C. Bain. Steel, vol. 87, no. 18, Oct. 30, 1930, pp. 57–59, 5 figs. Structure and metallographic nature of now familiar types of corrosion-resistant iron alloys; constitution diagrams illustrate stable phases observed in high-chromium low-carbon alloys; action of chromium in producing corrosion resistance. Presented before Am. Iron and Steel Inst., Oct. 24, 1930.

COMBUSTION

Automatic Control. Automatic Combustion Control AEG-Askania, F. Aschner A.E.G. Progress (Berlin), vol. 6, no. 10, Oct. 1930, pp. 312–316, 9 figs. Economy realized by installing automatic combustion regulators; functioning of automatic control; diagrams of regulation of flue-gas flap according to load by means of flue-gas volume; load regulation of traveling grate; elements of combustion control; control gear of jet-pipe regulator, step diaphragm influenced by steam pressure, and transmission lever are illustrated and discussed in some detail.

CONVEYORS

Shaking. The Duo-Mass Vibro Conveyor. Mech. Handling (Lond.), vol. 17, no. 8, Aug. 1930, pp. 250–251, 1 fig. Reciprocating conveyor which is fundamentally different from all other high-speed vibratory conveyors, manufactured under Schenck Heymann patents, having high frequency and low amplitude, which enables full use to be made of projectile effect of particles in transit.

COPPER ALLOYS

P.M.G. P.M.G. Metal Hardener. Machy. (Lond.), vol. 3, no. 942, Oct. 30, 1930, pp. 143–145, 4 figs. Results of tests on casting and forging with P.M.G. hardener, developed by Vickers-Armstrong; composed of copper, iron and silicon, and employed to replace tin in all copper alloys; tables give data on physical property and comparison of properties of cast P.M.G. metal and admiralty gunmetal; comparison of properties of forged P.M.G. metal with worked 70–30 brass and 9 per cent aluminum bronze.

CORE MAKING

Machine for. Manufacture of Cores With Compressed Air (Herstellung von Kernen mittels Druckluft), U. Lohse. V.D.I. Zeit. (Berlin), vol. 74, no. 43, Oct. 25, 1930, pp. 1479–1482, 17 figs. Design and operation of pneumatic core-making machine built by Albertuswerke, Hanover-Hainholz; sketches illustrate principal details; air consumption is 0.4 cu. m. per min. at atmospheric pressure; data on output and practical applications.

CRANES

Aluminum-Alloy. Shop Crane Built of Strong Aluminum Alloys, F. V. Hartman, and E. C. Hartmann. Eng. News-Rec., vol. 105, no. 16, Oct. 16, 1930, pp. 615–616, 2 figs. Crane of 10-ton capacity with 72 ft. span installed at Massena, N. Y., to compare with identical crane of steel; comparative weights of aluminum and steel 10-ton cranes.

Gantry—Electric Welding. Welding Applied to Gantry Crane Fabrication, R. F. Bessey. Eng. News-Rec., vol. 105, no. 18, Oct. 30, 1930, pp. 688–690, 3 figs. Report on economical use of welded steel in construction of four cranes of 71½-ft. span at lumber terminal in Brooklyn, and bottom chords are H-sections and no gusset-plate connections are used; typical welded details of main crane girder.

Luffing. Crane Which Maintains Load in Same Horizontal Plane With Varying Jib Radius (Einziehkrane mit waagerechter Lastbahn), K. Ruediger. Foerdertechnik und Frachtverkehr (Wittenberg), vol. 23, nos. 17 and 18, Aug. 15, 1930, pp. 333–337 and Aug. 29, pp. 358–361, 10 figs. Study of crane with stiff jib, obtaining horizontal movement of load with varying jib radius by using principal of elliptic guiding of jib; force diagrams; advantages and disadvantages; crane with hinged jib; crane obtaining horizontal movement of load with varying radius of jib by applying Lemniskaten links.

Power-Plant Erection. Erecting Cranes for Central Power Stations. Demag News (Duisburg) vol. 4, Oct. 1930, pp. 1–9, 24 figs. Twin overhead traveling crane for 300-tons working capacity; 150–50 tons crab with 5 tons auxiliary hoisting tackle; erection traveler with two 55-ton hoisting gears on common crab in engine hall of hydroelectric power station Karsefors near Laholm in Sweden; 2 times 55 tons crab; 50 ton gantry cranes, 102-ft. high, erecting thermal accumulators.

CRANKSHAFTS

Vibrations of. Calculation of Torsional Vibration, of Multi-Cylinder Engine (Beitrag zur Berechnung der Drehschwingungszahlen von Mehrzylindermaschinen), W. Benz. Automobiltechnische Zeit. (Berlin), vol. 33, no. 27, Sept. 30, 1930, pp. 648–659, 5 figs. Simplified methods for determining vibration period of first and second order system; multi-cylinder engine and one mass, respectively, Multi-cylinder engine and two masses by means of one chart; practical example is given.

Determination of Natural Vibration Period (Zur Bestimmung der Eigenschwingungszahlen von Kurbelwellen), K. Schlaefke. V.D.I. Zeit. (Berlin), vol. 74, no. 42, Oct. 18, 1930, pp. 1451–1453, 4 figs. Method of calculating natural vibration period of crankshaft with added mass at front end; graph illustrates effect of added mass.

CUPOLAS

Air Control. The Constant-Air-Weight Method of Cupola Blowing, H. V. Crawford. Gen. Elec. Rev., vol. 33, no. 11, Nov. 1930, pp. 626–633, 4 figs. Holder of Charles A. Coffin reward for development of methods of supplying cupola air by weight instead of by volume; outline cupola operation and electric equipment; fundamental requirements of iron melting in cupolas, i.e., combustion in cupola; amount of air required: volume method; amount of air required: weight method; pounds of air required per minute; comparison of volume and weight methods; effect of excess oxygen; effect of insufficient oxygen; method of operating cupola; etc.

Charging. Mechanical Cupola Charging, C. A. Hardy. Iron Age, vol. 126, no. 19, Nov. 6, 1930, pp. 1306–1308, 5 figs. Review of charging methods in different plants with particular regard to wish-bone system developed by Whiting Corp.; daily melts of 300 tons in 9 hr. are made up and charged into cupola with 5 men.

Mixture Calculation. Graphic Calculation of Cupola Mixtures With Special Regard to Pearlitic Cast Iron (Graphische Berechnung der Kupolofenmischungen mit besonderer Ruecksicht auf den Perlitguss), B. Szoeke. Giesserei (Duesseldorf), vol. 17, no. 42, Oct. 17, 1930, pp. 1013–1017, 9 figs. Graphic method of determining composition of burden is described, based on three examples, two of which relate to pearlitic cast iron.

CUTTING TOOLS

High-Speed-Steel. High-speed Steel Tipped Cutting Tools. Machy. (Lond.), vol. 37, no. 942, Oct. 30, 1930, pp. 137–140, 6 figs. Design and performance of J. B. R. tools made by Rennie Tool Co., East Manchester; effect of plan angles and cutting angles on cutting speed; cause of chattering; diamond-nosed tool; effect of back slope or front top rake on side slope or side top rake; regrinding of stag major tipped tools; heat-treating methods.

D

DIE CASTING

Alloys for. Die Casting Zinc and Aluminum, D. L. Colwell. Metal Progress, vol. 18, no. 5, Nov. 1930, pp. 58–63 and 100, 5 figs. Properties of zinc-base alloys and effect of lead, tin, copper, and vanadium; table gives data on composition and physical properties of aluminum-base and zinc-base alloy for various uses investigated by Committee B-6 of American Society for Testing Materials; plating and machining of die casting.

Machines. Design of Automatic Die Casting Dies, C. O. Herb. Machy. (Lond.), vol. 37, no. 941, Oct. 23, 1930, pp. 105–107, 4 figs. Design of movable and stationary dies having sliding cores that must be accurately located in relation to one another; construction details of die set in which small-diameter sliding core in movable die must register showing mechanism employed for moving cores of battery grid dies.

DIESEL-ELECTRIC POWER PLANTS

Argentina. Horizontal Diesel Engines (Liegende Dieselmotoren), J. Kremzar. V.D.I. Zeit. (Berlin), vol. 74, no. 42, Oct. 18, 1930, pp. 1449–1450, 5 figs. Principal features of two engines at electric power plant Puento Chico built by Skodawerke in Pilsen; each engine of 1500 hp. at 125 r.p.m. has two double-acting cylinders in tandem arrangement of 850 by 1250 mm. bore and stroke; graph illustrates performance data.

Industrial. Diesel Engines for Industrial Power in Heart of Chicago. Power Plant Eng., vol. 34, no. 21, Nov. 1, 1930, pp. 1224–1227, 6 figs. Machinery of Vesta Battery Corp. driven by Diesel power; plant independent of all outside power; construction features of engines; load curves showing summer and winter loads and uniform and fluctuating performance; cross-section of 300-hp. engine.

DIESEL ENGINES

Double-Acting. The Trend in Design of Double-Acting Two-Stroke Oil Engines, W. S. Burn. Mar. Engr. and Motorship Bldr. (Lond.), vol. 53, no. 636, Sept. 1930, pp. 333–336, 1 fig. Comparison of various cylinder construction; three types of air scavenging; shape of combustion space; annual combustion chambers. Abstract of paper read before Second World Power Conference, June 1930.

Fuel Injection. Effect of Orifice Length-Diameter Ratio on Spray Characteristics, A. G. Gelalles. Nat. Advisory Committee Aeronautics—Tech. Notes, no. 352, Oct. 1930, 14 pp., 9 figs. Effect of variations of orifice length to diameter ratio on spray characteristics for 0.014 in. and 0.040 in. orifice for ratios of 0.5 to 4.0; injection pressure varies from 4000 to 8000 lb. per sq. in.; air density into which fuel was sprayed was varied from density obtained with pressure of 60 lb. per sq. in. to density obtained with pressure of 250 lb. per sq. in. at room temperature.

Fuels. Crash Fire Tests With Diesel Oil, C. F. Taylor and E. S. Taylor. Aviation, vol. 29, no. 5, Nov. 1930, pp. 283–285, 8 figs. Superiority of Diesel oil from safety standpoint is illustrated by tests made at Massachusetts Institute of Technology to determine relative difficulty of ignition and speed of development of fires under conditions simulating wrecked airplanes, using gasoline and "Diesel" oil.

Ignition-Chamber. Diesel-Engine Investigations, Ignition-Chamber Engines, K. Neuman. Nat. Advisory Committee Aeronautics—Tech. Memo. no. 589, Oct. 1930, 30 pp., 9 figs. on supp. plates. Experiments, on single-cylinder 4-stroke-cycle 18-hp. engine; stroke, 316 mm.; cylinder diameter, 190 mm.; normal speed, 350 r.p.m.; analysis of flow in cylinder and ignition chamber; processes in cylinder and ignition chamber; ignition-chamber process advantageous for high-speed Diesel engines, because quick heat transmission to injected fuel can be effected by simple means with good atomization through high temperature and great turbulence. Translated from Dieselmaschinem IV, 1920.

DIPHENYL

Properties and Possibilities of. Physical Characteristics and Commercial Possibilities of Chlorinated Diphenyl, C. H. Penning. Indus. and Eng. Chem., vol. 22, no. 11, Nov. 1930, pp. 1180–1182, 1 fig. Commercial possibilities of physical properties of 2 and 4 chlorodiphenyl and their eutectic mixture, and physical characteristics of reproducible mixtures of more highly chlorinated isomers, which vary in consistency from that of light mobile oil through thick sirupy stage to solid resinous or crystalline state.

E

ELECTRIC FURNACES

Heat-Treating. High-Speed Steel Treated in a Special Electric Furnace, E. N. Brookings. Iron Age, vol. 126, no. 19, Nov. 6, 1930, pp. 1295–1298, and 1360, 2 figs. Details of construction and operation of electric hardening furnace at plant of Jones and Lamson Machine Co., Springfield, Vt. for treating threading chasers for automatic dies, taps, lathe tools, and miscellaneous parts.

ELECTRIC HOISTS

Design. Electric Hoisting Machinery in Germany and Other Countries (Elektrische Foerdermaschinen in Deutschland und im Auslande), E. h. W. Philippi. Elektrizitaet im Bergbau (Munich), vol. 5, no. 9, Sept. 15, 1930, pp. 165–171, 11 figs. Requirements of safety equipment in Germany; construction of speed regulators and brakes and corresponding equipment outside of Germany, with special regard to British Empire; comparison of complete equipment from mechanical and electrical standpoint in Germany and other countries.

ELECTRIC WELDING, ARC

Automatic. The Future of Automatic Arc Welding in the Boiler Industry, G. H. Koch. West. Machy. World, vol. 21, nos. 9 and 10, Sept. 1930, pp. 389–390, and Oct., pp. 434–437, 10 figs. Sept.: Advantages to boiler industry derived from safety and economy of electric arc welding. Oct.: Comparison of automatic and manual welding; table gives data on plate thickness, wire size, current and feet per hour.

BUCKET ELEVATORS

Discharge of. The Discharge of Bucket Elevators, W. H. Atherton. Mech. Handling (Lond.), vol. 17, no. 8, Aug. 1930, pp. 261–264, 10 figs. Discharge is influenced by nature of material, shape of buckets, speed of travel, diameter of top wheel, inclination of elevator and position of delivery shoot in relation to bucket during discharge period.

F

FANS

Centrifugal. Air-Operated Ventilating Fan Engineering (Lond.), vol. 130, no. 3380, Oct. 24, 1930, p. 540, 4 figs. Fan, designed by Holman Brothers, embodies Hele-Shaw Beacham air motor, and unit forms effective alternative to electric motor; it is 15-in. Sirocco centrifugal fan made by Davidson and Co.

Performance Characteristics. How to Analyze Disc and Propeller Fan Performance, C. A. Carpenter. Heat. and Vent., vol. 27, no. 10, Oct. 1930, pp. 87–91, 3 figs. Design features of propeller and disk type of fan; curves illustrating effect of contraction of diameter and area on air horsepower; chart illustrating relation between C.F.M. and air horsepower for various diameters.

FLOW OF FLUIDS

Discontinuous Layers. Discontinuous Layers in Hydrodynamics (Sur les surfaces de discontinuité en hydrodynamique), L. Escande and Teissié-Solier. Science et Industrie (Paris), vol. 14, no. 201, Oct. 1930, pp. 749–754, 13 figs. Theoretical and experimental study of flow around and through plates, cylinders and orifices, with special regard to methods of Camichel; satisfactory check of theory and experiment for flow around plate normal to current.

FOUNDRY PRACTICE

Metal Losses. Metal Losses and Melting Costs (Metallverlust und Schmelzkosten), E. Becker. Giesserei Zeitung (Berlin), vol. 27, no. 20, Oct. 15, 1930, pp. 565–567, 3 figs. Reasons for losses in foundry practice, losses in melting, casting, cleaning, and polishing; losses through theft; additional costs due to gates and defects, and to metal losses, with special reference to non-ferrous foundry practice.

FURNACES, MELTING

Pulverized-Coal. Steel Melting in an Acid-Lined Brackelsberg Furnace, P. Bardenheuer. Foundry Trade Jl. (Lond.), vol. 43, no. 740, Oct. 23, 1930, pp. 285–286, 1 fig. By using simple recuperator in which air fed into combustion chamber is preheated by exhaust gases to between 200 and 300 deg. cent., it is possible to obtain temperatures up to 1800 deg., making possible quick melting; steel melted in this furnace is distinguished by its good technological and mechanical properties; fuel consumption when melting 1 ton, is no greater than in largest, Siemens-Martin furnace.

G

GAGES

Tolerances. Wear and Tolerances on Gages, E. J. Bryant. Soc. Automotive Engrs.—Jl., vol. 27, no. 5, Nov. 1930, pp. 553–556. Tolerances for wear, as well as manufacturing tolerances for gages used in production; three possible dispositions of manufacturing tolerance for gages are discussed, author preferring to split gage-maker's tolerance on "not go gages," and on "go gages" to apply it to favor life of gage; alloy steel; chromium-plating; tungsten carbide.

GAS ENGINES

Foundations. Foundations of Gas-Engine Plant in Hamborn, Germany (Fundamente der Gasmaschinenzentrale Hamborn). Zement (Berlin), vol. 19, no. 23, June 5, 1930, pp. 541–543, 3 figs. Foundations for power house with four gas engines, driven with blast-furnace gas and furnishing compressed air for blast furnaces; strong vibrations of explosions require special foundation construction; details of reinforcement employed.

GASES

Specific Heat. Specific Heat of Gases (Chaleur spécifique des gaz), H. Lourie. Chaleur et Industrie (Paris), vol. 11, no. 125, Sept. 1930, pp. 423–435, 15 figs. Results and comparison of methods based on sound-wave measurements used by Kalaehne, Partington, Shilling, Dixon and Greenwood; tables and graphs give data on various gases.

GEARS

Heat Treatment. The Selection and Heat Treatment of Gear Steel, E. F. Davis. Fuels and Furnaces, vol. 8, no. 10, Oct. 1930, pp. 1341–1348 and 1385, 3 figs. Methods of obtaining uniform quality in production; effect of inclusions; control of grain structure and its effect on physical properties of various gear steels; carbon content; classification of various alloy steels with regard to heat treatment applied; tables give data on Izod impact and hardness value of oil hardening gear steels; composition of various grades of steel used for carburized gears.

Hobbing. Defects of Hobbed Gears, I. B. Mammano. Engineering (Lond.), vol. 130, no. 3379, Oct. 17, 1930, pp. 479–481, 5 figs. Defects of present hobbing process may be divided into two classes viz.: (1) absolutely unavoidable defects; (2) defects which are unavoidable with difficulty, owing to characteristics of machine; it is elimination or diminution of this class of errors that tests skill of gear maker.

Variable-Speed. A New Infinitely Variable Speed Drive, A. Page. Mech. World (Manchester), vol. 88, no. 2272, July 18, 1930, pp. 56–58, 10 figs. Gear made by Escher Wyss & Co., Switzerland, is of differential type, and its action depends on rolling of hardened and ground rollers on hardened surfaces; by varying mutual points of contact, uniform speed variation under constant load can be obtained within certain limits.

GRAPHIC CHARTS

Construction. The Construction of Diagrams for Formulas, H. L. Seward. Soc. Naval Architects and Mar. Engrs.—Advance Paper, no. 1, for mtg. Nov. 13–14, 1930, 21 pp., 32 figs. partly on supp. plates. Writer has been working for many years in this field and very, very seldom uses any mathematics beyond algebra and trigonometry; determinant notation; alignment diagrams; combination of diagrams; reconstruction; having taught and developed this subject with post-graduate students since 1908, he has built up a very extensive file of diagrams.

GRINDING

Precision. A Survey of Surface Quality Standards and Tolerance Costs Based on 1929–1930 Precision-Grinding Practice, R. E. W. Harrison. Am. Soc. Mech. Engrs.—Advance Paper, no. 25, Dec. 1–5, 1930, 10 pp., 15 figs. Defects in present-day accepted standards of finish of mechanical components; size control and its effect on cost of production as well as length of useful life; definite standards of finish and electrical finish-calibrating instrument; benefits derived from close adherence to true limits of accuracy.

H

HARDNESS TESTING

Ball Hardness Tests. A New Method of Making Ball Hardness Tests of Metals; and a Plotting Table for the Simplification of "Meyer (Hardness) Analysis," H. O'Neill. Iron and Steel Inst.—Carnegie Scholarship Memoirs (Lond.), vol. 19, 1930, pp. 19–38, 4 figs., partly on supp. Hardness and hardness scale; desiderata for practical hardness test; criticism of

some existing tests; author's diamond ball hardness test; construction of experimental testing machine; behavior of experimental machine; Meyer hardness analysis. Bibliography on ball hardness testing.

Microcharacter Tester. Microcharacter Hardness Tester Avoids Core Effect, C. H. Bierbaum. Iron Age, vol. 126, no. 17, Oct. 23, 1930, p. 1143, 1 fig. Measurement of hardness by moving highly polished surface to be tested under hard cutting point of jewel, subjected to definite load, giving it very slow movement and then measuring width of cut produced; curve of hardness penetration in nitrided specimen as developed by microcharacter tester shows maximum hardness short distance in, instead of at surface. Paper read before Am. Soc. Steel Testing.

HEAT-INSULATING MATERIALS

Mineral Wool. Silicate Wool, and Insulating Material for High Temperatures (Silikatwolle ein Isoliermaterial fuer Hochtemperaturen), H. Guenther. Feuerungstechnik (Lepizig), vol. 18, no. 19–20, Oct. 15, 1930, pp. 194–195. Manufacture, properties and uses of mineral wool, made from blast-furnace slag, or according to process decribed in a new German patent, from house refuse from which other valuable wastes such as paper, rags, tin cans, leather, etc., have been removed.

Properties. Heat Insulation With Particular Regard to Modern Methods (Ueber Waermeschutz-Isolierungen unter besonderer Beruecksichtigung der neuen Verfahren), K. Brandt. Maschinenkonstructeur (Leipzig), vol. 63, no. 19, Oct. 10, 1930, pp. 370–374, 6 figs. Characteristics and applications of principal materials; table gives data on properties of D.P.G. material, Kieselgur, and glass wool.

HEAT TRANSMISSION

Air Spaces. Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces, L. W. Schad. Heat. Piping and Air Conditioning, vol. 2, no. 11, Nov. 1930, pp. 957–963, 4 figs. Information relative to value of bright metal reflecting screens placed in heat path through air; two test methods employed for purpose of obtaining data on thermal transmission; heat dissipation from bright tin surfaces; heat transfer through air spaces.

HYDRAULIC MACHINERY

Cavitation. Experimental and Theoretical Investigations of Cavitation in Water (Experimentelle und theoretische Untersuchungen ueber Hohlraumbildung (Kavitation) im Wasser), J. Ackeret. V.D.I. Zeit. (Berlin), vol. 74, no. 9, Mar. 1, 1930, p. 264. Investigation of simple types of flow, such as those of round blades, through channels, and past spheres, has been done at Goettingen; it was found that many apparently widely different types of cavitation are of quite common characteristics; investigations show that at the core of bubbles the shock pressure is sufficient to cause observed breakdown of material.

HYDRAULIC TURBINES

Leakage. Reducing Gate Leakage Saves $36,000 a Year, E. B. Strowger. Elec. World, vol. 96, no. 11, Sept. 13, 1930, pp. 481–484, 1 fig. Results of nearly 100 leakage tests made on turbines of various size and make given in table; average gate leakage of 40 new units is 1.1 per cent of rated discharge of turbine, while corresponding value for 37 old units is 6.1 per cent; distribution of station load among units operated in most efficient manner is indicated by test curves.

Pitting. Pitting in Water Turbines, E. Englesson. Engineer (Lond.), vol. 150, no. 3901, Oct. 17, 1930, pp. 418–421, 16 figs. It has been found that frequently sudden and severe pitting, which appears in water turbines as well as propellers, is consequence of cavitation; factors which cause cavitation; bubbles and pitting; microscopic investigations of pitted turbine parts; accelerating action of corrosion in pitting; what can be done to avoid pitting; properties of material to resist pitting by cavitation; test results.

HYDROELECTRIC POWER PLANTS

Automatic. Automatic Operator Controls Hydro Plant Economy, S. L. Kerr. Power, vol. 72, no. 18, Oct. 28, 1930, pp. 698–699, 2 figs. In Morony hydro plant of Montana Power Company automatic operator is used that controls loading of two units to give highest economy; when only one unit is required to carry load other is automatically made to operate as synchronous condenser until it is again needed. Abstract from paper, "Automatic Operation for Economy Control Applied to Hydroelectric Generator Stations," presented before Am. Inst. of Elec. Engrs.

I

INDUSTRIAL MANAGEMENT

Automobile Plants. Future Production Activity Forming in Economic Mold, K. T. Keller, Automotive Industries, vol. 63, no. 16, Oct. 18, 1930, pp. 541–543 and 559. Analysis of factors controlling economic production; elements involved in tooling up; inventory control; material handling and overhead; personnel relationships.

Forge Shops. Management in Forge Shops (Betriebswirtschaft in Schmiedebetrieben), H. Klinar. Stahl und Eisen (Duesseldorf), vol. 50, no. 41, Oct. 9, 1930, pp. 1425–1430, 13 figs. Investigations of fuel consumption of forging furnaces; no-load requirement; influence of furnace attendance and loading; steam consumption of hammers; influence of hammer drive and operation; increasing production by proper distribution of work; influence of forging costs.

Foundries—Time Study. Conditions Governing Introduction of Time and Motion Studies in Foundry Practice (Vorbedingungen zur Einfuehrung der Arbeits- und Zeitstudien in Giessereibetrieben), G. Taens. Zeit. fuer die Gesamte Giessereipraxis (Berlin), vol. 51, no. 5, Feb. 2, 1930, pp. 41–43, 2 figs. Advantages gained by application of time studies are demonstrated by success in American industry; increase in production is always accompanied by decrease in production costs resulting in reduction of selling price.

Foundries. Fundamentals of Rational Organization in the Foundry (Les bases de l'organization rationnelle dans la fonderie), G. Ivanow. Revue Industrielle (Paris), vol. 60, no. 2254, Sept. 1930, pp. 569–574, 8 figs. Preparation and carrying out of work in its various details; time study; samples of cards used in system.

Production Control. How to Regulate Idle Equipment Delays, J. J. Berliner. Mill and Factory Illustrated, vol. 7, no. 5, Nov. 1930, pp. 29–30 and 84, 2 figs. Causes of idle machines discussed are no operator, no material, orders, machine breakdown or under repairs, no power, awaiting set-up, waiting for tools and awaiting instructions.

The Effect of Time on Production Cost, P. Lehoczky. Metal Stampings, vol. 3, no. 10, Oct. 1930, pp. 919–921. Savings made possible by using economic lot sizes; formulas and their practical application for estimating purposes and measuring managerial efficiency; decreasing time required for doing one or several operations, material tie-up, increasing number of turnovers, and reducing capital investment.

INTERNAL-COMBUSTION ENGINES

Cylinder Linings. High Heat Expansion Cast Iron Developed for Cylinder Linings. Automotive Industries, vol. 63, no. 18, Nov. 1, 1930, pp. 656–657, 2 figs. Properties of new alloy iron developed by International Nickel Co., Bayonne, N. J.; expansion is 50 per cent greater than that of ordinary gray iron; graph illustrates typical hardness and corrosion characteristics; oxidation and growth of plain cast iron and corrosion-resisting cast iron at 1500 deg. fahr.

Rotary. Rotary Opposed-piston Engine. Motor Transport (Lond.), vol. 51, no. 1336, Oct. 20, 1930, pp. 450–451, 1 fig. Principle of low-weight engine designed by A. Roger, with rotating single cylinder in which are two opposed pistons, driving two crankshafts at opposite ends thereof; crankshafts are geared to stationary wheel.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; OIL ENGINES.]

IRON

Welding Properties. Weldability of Iron (Ueber die Presschweissbarkeit des Eisens), H. Esser. Archiv. fuer das Eisenhuettenwesen (Duesseldorf), vol. 4, no. 4, Oct. 1930, pp. 199–206, 22 figs. Discussion deals only with pressure welding as opposed to fusion welding, that is, joining under pressure of two workpieces in plastic state, such as hammer welding, electric resistance welding, aluminum thermal welding; results of earlier studies; tensile and bending test; influence of different welding temperatures, surface conditions, and carbon content on weldability.

IRON AND STEEL PLANTS

Skoda Works, Czechoslovakia. The Skoda Works, Pilsen. Engineer (Lond.), vol. 150, no. 3899, Oct. 3, 1930, pp. 362–364, 3 figs. Works employ staff of 25,600; products include iron and steel castings and forgings, special cast irons, and wide range of ordinary and special steels, forged parts up to 105 tons in weight, mining and metallurgical machinery, marine and locomotive products, engines, turbines, motor cars, trucks, and airplanes.

K

KEYS AND KEYWAYS

Standardization. British Standard Keys and Keyways, W. R. Needham. Iron Age, vol. 126, no. 19, Nov. 1930, pp. 1303–1305 and 1360, 7 figs. British Engineering Standards Association recommendations officially offered in Specification no. 46, part 1, 1929; comparison of shaft and key and keyway stresses; measurement of depth of keyway at side of keyway, rather than at center; table gives data on stress and pressure intensities.

L

LOCOMOTIVES

Design. Steam Locomotive Design: Data and Formulae, E. A. Phillipson. Locomotive (Lond.), vol. 36, nos. 457 and 458, Sept. 15, 1930, pp. 301–304 and Oct. 15, pp. 335–337, 1 fig., Sept. 15: Design features of drop grates; ashpan; dampers; tubeplates; small and large tube. Oct. 15: Design features of tube layout; boiler and girder stays; firebox side stays; roof stays; longitudinal staying.

Diesel. Heavy Oil Locomotive for Plantation Service. Locomotive (Lond.), vol. 36, no. 457, Sept. 15, 1930, pp. 293–295, 2 figs. Locomotive designed and constructed by Avonside Engine Co., Ltd., of Bristol, for plantation work and to operate on 2 ft. gage; 6-cylinder Diesel engines, 57 hp. and 1000 r.p.m. and 68 hp. at 1200 r.p.m.; total wheel base 15 ft. 0 in.; rated tractive effort at 8 m.p.h.; 2000 lb.

Diesel-Electric. Diesel-Electric Trains. Elecn. (Lond.), vol. 105, no. 2724, Aug. 15, 1930, pp. 199–200, 5 figs. Growing popularity; advantages of electrification without heavy capital cost of central generation and track equipment; taking average price of locomotive coal as 20s per ton, there would be total saving on fuel alone of 7,000,000 to 9,000,000 pounds sterling per annum on railways of Great Britain and with no greater capital expenditure; Armstrong-Sulzer equipment used in Russia and other countries is illustrated.

Oil-Electric. An 800-Hp. Oil-Electric Locomotive, A. R. Brown. Motive Power, vol. 1, no. 9, Oct. 1930, pp. 20–22 and 48–49, 7 figs. Use of high-speed oil engines and visibility type cab features of 800-hp., 110-ton Baldwin-Westinghouse locomotive; 6-cylinder Westinghouse oil engines each develop 400 hp. at 900 r.p.m. and are development of high-speed, light weight types which have been extensively used on Canadian National Railways; electrical loading; weight transfer compensation; cooling and heating system; air brakes; electrical apparatus.

The Internal Combustion Engine as an Adjunct to Electrification, A. H. Candee. Am. Inst. Elec. Engrs.—Advance Paper, no. 162, for mtg. Oct. 13–15, 1930, 4 pp., 11 figs. Substitution of oil or gas-electric motor cars for operating to adjoining branch lines and of oil-electric locomotives for yards difficult to electrify offers number of advantages; multiple-unit DeLuxe rail cars facilitate terminal operation and attract branch line traffic; oil-electric equipment may be operated through tunnels; switching is expedited by oil-electric locomotives; advantages lie in elimination of smoke and dirt; increased economics of operation and improved and consolidated maintenance forces.

Passenger. Some Modern American Passenger Locomotives, E. C. Poultney. Ry. Engr. (Lond.), vol. 51, no. 609, Oct. 1930, pp. 386–389, 2 figs. Tabular comparison of design characteristics of some recent high-powered American locomotives for express passenger service; curves illustrating operating characteristics.

Steam-Turbine. Tests on Steam Turbine Locomotive Type Krupp-Zoelly (Versuche mit der Dampfturbinen-Lokomotive Bauart Krupp-Zoelly). Schweizerische Bauzeitung (Zurich), vol. 96, no. 9, Aug. 30, 1930, pp. 106–109, 14 figs. Principles of operation and performance data are illustrated by graphs and diagrams; at 1250 hp., coal consumption reaches minimum of 0.75 kg. per hp-hr.

Tank. 2-6-2 Type Locomotives on the London and Northeastern Railway. Engineering (Lond.), vol. 130, no. 3377, Oct. 3, 1930, p. 428, 3 figs. New class is being introduced by H. N. Gresley, on London and Northeastern Railway built at company's Doncaster works, known as V. I. type; they have three cylinders, 16 in. in diam. by 26 in. stroke, and piston valves; steam distribution for outside cylinders is effected by Walschaert gear, inside being operated by Gresley gear.

LUBRICATING OIL

Testing. The Work Factor of Lubricating Oil, J. G. O'Neill. Am. Soc. Mech. Engrs.—Advance paper no. 40, for mtg., Dec. 1–5, 1930, 5 pp., 4 figs. New method proposed for evaluating lubricating oils seeks to extend application of standard laboratory tests in that their results will indicate service that will be obtained from oils in actual operation: increases in viscosity, neutralization number, precipitation number, and per cent of carbon residue of lubricating oil when subjected to endurance test, which simulates service conditions as found in forced-feed lubrication system, are expressed numerically by means of formulas, and average of these results is called work factor of oil.

M

MACHINE TOOLS

Hydraulic Drive. Progress in Hydraulic Drive of Machine Tools (Neueste Entwicklung der hydrulischen Antriebe von Werkzeugmaschinen). Maschinenkonstrukteur (Leipzig), vol. 63, no. 19, Oct. 10, 1930, pp. 383–386, 11 figs. Principles and sketches of various types of drives; Hele-Shaw-Beacham pump; Oil gear drives; Stoz and Sturm drives; other makes are Lauf-Thoma, Enor, Hahn, and Kolb.

Replacement. Purchase of Machine Tools Justified on the Basis of Financial Returns, E. F. Dubrul. Automotive Industries, vol. 63, no. 16, Oct. 18, 1930, pp. 565–566. Losses due to obsolete equipment are discussed and formula derived to show that new tools can show profit in savings equivalent to bond yield.

MACHINES

Dynamical Analysis of. Dynamical Analysis of Machines, R. Eksergian. Franklin Inst.—Jl., vol. 210, no. 5, Nov. 1930, pp. 645–658, 6 figs. Rolling of cylinders in contact; pendulum suspended from axis of rotating cylinder which rolls on horizontal plane; motion of wheel rolling on moving cylindrical wedge; reaction of eccentric weighted roller on accelerated frame.

MATERIALS HANDLING

Coal Docks. Loading Six Million Tons of Coal, J. A. Stocker, C. S. Albright, R. E. Rice and W. P. Brown. Civil Eng., vol. 1, no. 2, Nov. 1930, pp. 99–106, 5 figs. Symposium of 3 papers; description of New York Central coal dock and car dumper plant at Toledo, Ohio; average tonnage handled per year is 33,220,928; boat loading statistics; requirements of design; yard and track layout; operating characteristics; features of electric 30-ton car pushers; electrical operation of car dumper; structural design and details of south car dumper; design of stationary superstructure; movable parts.

Mines and Steel Plants. Modern Conveying Methods in Mines and Metallurgical Plants (Neuzeitliche Foerdereinrichtungen in Berbau und Huettenbetrieb), H. Netz. Foerdertechnik und Frachtverkehr (Wittenberg), vol. 23, nos. 19 and 20, Sept. 12, 1930, pp. 369–374 and Sept. 26, pp. 396–400, 27 figs. Conveyors used in mines, such as belt conveyors, chutes, skip hoists, and winches; equipment in metallurgical plants, such as rolling-mill conveyors, automatic cooling beds, ingot-handling equipment; conveyors for annealing furnaces, etc.

Paper and Pulp Mills. Esparto Grass Mechanical Handling Plant. Engineering (Lond.), vol. 130, no. 3379, Oct. 17, 1930, pp. 487–488, 4 figs. on supp. plate. Methods developed by Spencer (Melksham) in handling raw Esparto grass for paper mills of John Dickinson and Co., Watford; grass resembles hay in appearance but it is much tougher and more wiry; in passage from bin to boilers, grass has to be weighed and dust and foreign bodies in it removed, and whole process must be continuous to avoid any delay in charging boilers.

Rolling Mills. Handling Pipe in Process at an Eastern Rolling Mill. Iron Age, vol. 126, no. 16, Oct. 16, 1930, pp. 1058–1059 and 1119, 3 figs. How fundamental considerations are applied to actual materials-handling problem can be explained by examination of solution of problem which presented itself at plant of rolling-mill company handling 80 tons of butt-welded pipe a day; conveying equipment was furnished by Cleveland Electric Tramrail Division of Cleveland Crane & Engineering Co., Wickliffe, Ohio.

MEASURING INSTRUMENTS

Comparators. Optical Measuring Instrument as Practical Shop Tools, J. W. Marshall. Iron Age, vol. 126, no. 20, Nov. 13, 1930, pp. 1372–1373, 4 figs. Operating principles and use of Hartness comparator, built by Jones & Lamson Machine Co., Springfield, Vt.; advantages derived from using optical comparator as contrasted with mechanical gages in measuring screws, poppet valves, dental burrs; speed in operation and accuracy.

METALS

Cleaning. Electrolytic Metal Cleaning Without Corrosion. Chem. and Met. Eng., vol. 37, no. 10, Oct. 1930, pp. 634–635, 3 figs. Features of recently patented Bullard-Dunn process of metal cleaning; metallic film deposits on metal to be cleaned the instant each particle of scale is removed; equipment includes two steam-heated, ventilated tanks, and two wash tanks; solution for acid bath using lead anodes contains few ounces each of sulphuric acid, hydrochloric acid, and common salt per gallon of water; caustic solution contains small quantity of trisodium phosphate, soda ash, and caustic soda.

Corrosion Prevention. New Methods in Study of Corrosion and Protection of Metallurgical Products Against Corrosion (Quelques nouveautés d'ordre chimique dans l'étude de la corrosion et dans la protection des produits métallurgiques contre la corrosion), J. Cournot. Société Chimique de France—Bul. (Paris), vol. 47–48, no. 8, Aug. 1930, pp. 802–825. Theories of corrosion and experimental methods of investigation available; résumé of methods of protection of metals from corrosion, especially by coating with other metals or with paints, and by anodic treatment.

Rust Protection of Machinery by Phosphate Containing Baths (Der Rostschulz von Maschinen durch phosphathaltige Baeder), H. Kalpers. Maschinenkonstrukteur (Munich), vol. 63, no. 20, Oct. 25, 1930, pp. 395–398, 7 figs. Chemical reactions in parkerizing process and data on concentration of solution; table gives data on parkerized, sherardized, galvanized nickel plated, and otherwise protected surfaces regarding air corrosion resistance under different conditions of exposure.

Deep Drawing. Actual Relations Between Thickness of Plate and Erichsen Deep Drawing Capacity (Die wirklichen Beziehungen zwischen Blechdicke und Erichsen-Tiefung), K. Daeves. Stahl und Eisen (Duesseldorf), vol. 50, no. 43, Oct. 23, 1930, p. 1501, 1 fig. In order to ascertain manner in which deep-drawing values obtained with Erichsen apparatus are dependent upon thickness of sheet, large-scale statistical research was applied to determine frequency maxima for double-pickled punched plates of 0.2 to 2 mm. thickness; 4000 values obtained in one plant served as basis.

Endurance Testing. Experiences With Testing of Endurance of Different Materials on M.A.N. Bending Vibration Machine (Erfahrungen ueber die Pruefung der Dauerfestigkeit verschiedener Werkstoffe auf der MAN-Biegeschwingungsmaschine), A. Juenger. Mitteilungen aus den Forschungsanstalten (Nuernberg), vol. 1, no. 1, Sept. 1930, pp. 8–18, 22 figs. Normal bending-strength values of 25 different metals in polished state were determined; results obtained on this machine are practically same as are obtained on Schenk and other machines with rotating test bar; influence of different surface conditions and of welding on bending strength was also determined.

Hard Facing. Economies Result From Welded-On Overlays and Heat Treatment. Iron Age, vol. 126, no. 20, Nov. 13, 1930, pp. 1370–1371 and 1437–1438, 3 figs. Procedure and results of series of investigations, extending over eight years; ascertaining value of welded-on overlays as surface preparation for machine and other parts; M. C. Smith, Relationship Between Welded-On Overlays and Heat Treatment. Paper presented before Am. Soc. for Steel Treating.

Properties. Allowable Stresses of Materials for Machinery Construction (Zulaessige Spannungen der im Maschinenbau verwendeten Werkstoffe), E. Bock. Machinenbau (Berlin), vol. 9, no. 19, Oct. 2, 1930, pp. 637–640. Admissible stresses of materials in relation to elasticity, deformation, notch effect, determination of base load; tables give data on permissible stresses for various kinds of steel, cast iron different conditions of loading.

MICROMANOMETERS

Calibration. Micromanometers and Their Calibration (Om Mikro-Manometrar Och Deras Kalibrering), D. Bratt. Teknisk Tidksrift (Stockholm), vol. 60, nos. 41 and 42, Oct. 11, 1930, pp. 573–578, and Oct. 18, pp. 587–591, 13 figs. Method developed by Swedish Ingenioers-vetenskapsakadermien's Elektrovaerme-Institut for calibrating micromanometers with highest possible degree of exactitude; method is very simple and almost unlimited number of instruments may be calibrated simultaneously with degree of accuracy not less than 0.001 gram per sq. cm.; inexactitude of other methods is proved by comparison of control readings.

High-Sensitivity. A Micromanometer of High Sensitivity, E. Ower. Lond., Edinburgh and Dublin Philosophical Mag. and Jl. of Science (Lond.), vol. 10, no. 65, Oct. 1930, pp. 544–551, 3 figs. In view of increased attention paid in recent years to measurement of low air speeds, it is desirable to extend calibration and use of pitot-static tube to much lower speeds; many different devices were examined before solution was found; finally author came across references to papers by B. J. P. Roberts and A. Henry describing proposals for manometers consisting, in effect, of U-tubes having their two vertical limbs connected by length of horizontal capillary tubing in which small air-bubble separates two columns of liquid.

O

OIL ENGINES

Design. The Present Position of the High Speed Heavy-Oil Engine, S. J. Davies and F. Giffen. Engineering (Lond.), vol. 130, no. 3380, Oct. 24, 1930, pp. 532–537, 3 figs. Engines considered are limited to those in which fuel is injected in liquid form into combustion space and with speeds of revolution exceeding 800 r.p.m.; relative merits of gasoline and heavy-oil engines; discussion of different designs; comparison of three groups, British, Continental and American. Paper read before Section G of Brit. Assn., Sept. 4, 1930.

Richardson-Westgarth. Large Oil Engines and The Grid, W. S. Burn. Power Engr. (Lond.), vol. 25, no. 295, Oct. 1930, pp. 370–375, 3 figs. Adaptability of large oil engines for generation of electricity; first British engine of type suitable for large powers, although of only 1000 kw. capacity, is at present being installed at Ashford Electricity Works; design features of oil-engine generating plant; engine details are given.

OPEN-HEARTH FURNACES

Arches. Heat Losses and Durability of Open-Hearth Furnace Arch During Life of Furnace (Waermeverluste und Haltbarkeit des Siemens-Martin-Ofengewoelbes waehrend einer Ofenreise), A. Schlueter. Stahl und Eisen (Duesseldorf), vol. 50, no. 40, Oct. 2, 1930, pp. 1393–1396 and (discussion), pp. 1396–1397, 7 figs. Surface-temperature measurements of arch; influence of heat loss of arch on heat consumption of hearth and of whole furnace; normal wear of arch.

Control. Automatic Combustion Control for Open Hearth Furnaces, R. W. Simpson. Iron and Steel Engr., vol. 7, no. 10, Oct. 1930, pp. 485–487, 3 figs. Review of relative merits of different methods of measuring and apportioning air and fuel for liquid and gaseous fuels.

Fuels. Mixed Gases in Open-Hearth Furnaces, G. E. Rose and F. M. Washburn. Blast Furnace and Steel Plant, vol. 18, nos. 9 and 10, Sept. 1930, pp. 1476–1479 and Oct., pp. 1621–1623, 4 figs. Experiences in operation of furnace with mixture of coke-oven and blast-furnace gas; sketch shows operation of Rose movable ports; graph illustrates effect of preheating of gas upon transfer of heat from flame; comparative statement of cost of brick repairs with oil-fired furnaces; detail data on heat consumption, temperature, and charge. Paper presented before Am. Iron and Steel Elec. Engrs.

OXYACETYLENE WELDING

Flame Temperature. Welding Facts and Figures, D. Richardson. Welding Jl. (Lond.), vol. 27, no. 325, Oct. 1930, pp. 294–296, 1 fig. Review of principal literature with particular regard to work on oxyacetylene flame and blow-pipe efficiency by A. Stephenson; graph illustrates temperature at various distances from tip of white cone; requirement of blow-pipe design especially of low-pressure type.

OXYGEN

Thermodynamic Properties. Volumes of State of Oxygen at Low Temperatures (With Dia-

grams) Die Zustandsgroessen des Sauerstoffs bei tiefen Temperaturen mit Diagrammen), F. Schmidt. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens (Berlin), no. 339, 1930, 20 pp., 11 figs. Comprehensive treatment of thermodynamic properties of oxygen; equation is established by author based on that of van der Waals which reproduces results with mean exactitude of 0.5 per cent; with its aid complete pv diagram was drawn; diagrams should be of value to engineering, and should serve to complete knowledge of behavior of gases at low temperatures generally.

P

PINS

Machinery. Proposed Machine-Pin Standard. Soc. Automotive Engrs.—Jl., vol. 27, no. 5, Nov. 1930, pp. 605 and 617, 2 figs. Tables give dimensions for taper and cylindrical pins submitted by American Standards Association Committee; objectionable features of present series of pins; related dimensions of pins and their reamers.

PIPE LINES

Underground, Heat Losses in. Heat Losses of Underground Pipe and Cooling Losses of Pipe Lines (Waermeverluste von Erdleitungen und Auskuehlungsverluste von Rohrleitungen), O. Krischer. Waerme (Berlin), vol. 53, no. 40, Oct. 4, 1930, pp. 759–762, 4 figs. Formulas for determination of heat losses based on theoretical principles for investigation of influences of conduit size and temperature, and comparison of heat losses of different systems of underground construction with those of overhead and indoor pipe lines; best insulation is effected with small conduits at low temperatures; at higher temperatures, insulating effect of earth is greater than that of air.

POWER GENERATION

Ocean Tides. Power From Tides. Elecn. (Lond.), vol. 105, no. 2731, Oct. 3, 1930, p. 411, 3 figs. Experiment in production of electricity from tidal power was demonstrated last week at Avonmouth Dock, where experimental plant working on system devised by P. Shishkoff, has been erected by Hydro Thermal Power Ltd.; power is generated at 0.2d per kw-hr.

Polar Seas. Energy Supply in the Artic Regions, Barjot. World Power (Lond.), vol. 14, no. 82, Oct. 1930, pp. 305–306. Barjot process for extracting energy from unfrozen waters beneath surface ice; article deals in particular with economic aspect of subject; regions suitable for application of Barjot system. Abstract of paper read before World Power Conference, Berlin.

POWER PLANTS

Operation. Probability Calculus in Operation of Large Power Plants (Wahrscheinlichkeitsrechnung beim Betrieb grosser Kraftwerke), E. Weber. Wissenschaftliche Veroeffentlichungen aus dem Siemens-Konzern (Berlin) vol. 9, no. 2, June 12, 1930, pp. 64–76, 10 figs. Gauss' theory of observation errors; application of theory to occurrences in time; simultaneous connecting of several consumers of simple characteristics; simultaneous switching without starters of several d.c. motors.

PREFERRED NUMBERS

German Series. Preferred Numbers and Standardization of Revolutions per Minute (Normungszahlen und Drehzahlnormung—Die neue Fassung der Normungszahlen), O. Kienzle and G. Schlesinger. Werkstattstechnik (Berlin), vol. 24, no. 19, Oct. 1, 1930, pp. 517–522. Two separate articles on German series of preferred numbers (DIN 323); reasons for new arrangement are explained and illustrated by practical applications; tables give data on idling speed for machine tools and gears.

PRESSES

Plate-Bending. Built-Up Hydraulic Bending-Press. Engineering (Lond.), vol. 130, no. 3378, Oct. 10, 1930, p. 471. Press constructed by Hydraulik G.m.b.H., Duisburg, for bending of ship plating for cruisers, can exert load of 1000 tons; cranes have jibs of fixed height carrying electrically operated crabs, lifting gear being controlled from floor and transversed by hand; new method of construction employed in this press has proved more economical than adoption of steel castings, which have hitherto been generally used.

PULVERIZED COAL

Volume Measurement. Volume Measurement of Pulverized Coal (Kohlenstaubmengenmesser), W. Schuites. Archiv. fuer Waermewirtschaft (Berlin), vol. 11, no. 11, Nov. 1930, pp. 371–375, 9 figs. Result of award instituted by Pulverized Coal Committee of German National Coal Council (Reichskoulenrat), for design of pulverized-coal volumeter; physical principles on which award was based; different types of meters.

PYROMETERS

Optical. Theory of Optical Pyrometers With Partial Radiation and Description of Some New Improvements (Théorie des pyromètres optiques à rayonnement partiel et description de quelques nouveaux perfectionnements), S. Held. Chaleur et Industrie (Paris), vol. 11, no. 125, Sept. 1930, pp. 403–410, 7 figs. Design and operating principles of instruments made by Chauvin et Arnoux; portable instruments using auxiliary variable light source covering ranges from 600 to 3500 deg. cent.

Pyrovisor. A New Method of Measuring Temperature. Heat Treating and Forging, vol. 16, no. 10, Oct. 1930, pp. 1327–1328, 2 figs. Principles and operation of color pyrometer based on comparison of intensity of two monochromatic radiations; pyrometer handled under trade name "Pyrovisor" by American Demag Corp., does not require any auxiliary apparatus like batteries, incandescent lamps, etc., and can be used indefinitely without any calibration; temperature readings are made in very short time and it is possible to measure temperature of largest as well as smallest bodies.

R

RAIL MOTOR CARS

Construction and Maintenance. The Construction, Operation and Maintenance of Unit Cars, T. H. Dickson. Eng. Jl. (Montreal), vol. 13, no. 10, Oct. 1930, pp. 580–584, 5 figs. Outline of causes for development of gas-mechanical, gas-electric, storage battery, and distillate electric cars, oil-electrics, etc.; features of such cars; fuel; maintenance. Paper read before Eng. Inst. of Can.

France. Rail Motor Cars and Tractors (Draisines et tracteurs sur vois ferrées), R. Barnerias. Arts et Métiers (Paris), no. 120, Sept. 1930, pp. 364–371, 8 figs. Review of characteristics of light rail motor cars for transportation and maintenance purposes; types of 15 to 65 hp. with speeds of 50 to 60 km. per hr.

RIVETED JOINTS

Welded-Seam Reinforcement. Tests of Combined Action of Riveted Joints With Welded Seams (Versuche ueber das Zusammenwirken von Nietverbindung und Schweissnaht), H. Kayser. Stahlbau (Berlin), vol. 3, no. 13, June 27, 1930, pp. 145–147, 5 figs. Laboratory tests of riveted joints reinforced with welded seams, in connection with proposed strengthening of existing riveted-steel bridge, have demonstrated advisability of increasing strength of riveted joints with welding around edge of riveted plate.

ROLLING MILLS

Brass. Iron and Steel Used in a Modern Brass and Copper Mill, H. G. Keshian. Iron Age, vol. 126, no. 19, Nov. 6, 1930, pp. 1282–1286, and 1359–1360, 7 figs. Steel rolls replacing chilled-iron rolls, plain carbon and alloy tool steels for shearing alloy steel for cold-drawing equipment, such as chains, dies, etc.; materials used in hot working, hot piercing and forging; extrusion die steels.

Electric Drive. Three-Phase Drive of Tube Mills and Reconstruction of a Strip Mill (Drehstromantriebe von Rohrwalzwerken und Umbau einer Streifenstrasse), W. Albrecht. Stahl und Eisen (Duesseldorf), vol. 50, no. 42, Oct. 16, 1930, pp. 1457–1462, 7 figs. Choice of drive for inclines and pilger rolling mill; description of strip mill before and after conversion of electric drive; data on saving effected and increase in efficiency.

Synchronous Motors for Main-Roll Drive, H. W. Harper. Elec. Jl., vol. 27, no. 11, Nov. 1930, pp. 657–659, 4 figs. With increasing amount of attention now given to power-factor conditions, and notable improvements made in design of synchronous motors, this type of drive merits serious consideration for almost any large or reasonably large constant-speed application.

RUBBER TIRES

Motor-Truck. The Interrelated Effects of Load, Speed, Tires, and Road Roughness on Motor Truck Impact, J. A. Buchanan. Pub. Roads, vol. 11, no. 7, Sept. 1930, pp. 139–152, 15 figs. Part of investigation of motor-truck impact conducted by Bureau of Public Roads, Rubber Manufacturers Association, and Society of Automotive Engineers; tests covered wide range in speeds and condition of road surface; methods of expressing impact values; calibration of roughness of test sections with relative roughness indicator; isograms used to present data; isodynamic curves for determination of vertical reactions; impact of partially worn solid tires; regulating vehicle speed according to tire equipment.

S

SEAPLANES

Passenger. 4-Engined Short Flying Boat. Flight (Lond.), vol. 22, no. 42, Oct. 17, 1930, pp. 1130–1132, 2 figs. Outstanding features in design of flying boat for 16 passengers and 1400 lb. of mails; length o.a. 78 ft.; wing span (upper), 113 ft.; wing span (lower), 92 ft. 6 in.; tare weight (including cabin equipment), 17,900 lb.; gross weight, 30, 310 lb.; disposable load 12,410 lb.; maximum speed at 5000 ft., 132 m.p.h.; cruising speed at 5000 ft., 100 m.p.h.

Testing. Tunnel Tests on High-Speed Seaplanes, W. L. Cowley. Aircraft Eng. (Lond.), vol. 2, no. 20, Oct. 1930, pp. 247–248, 1 fig. Summarized results of N.P.L. researches on British 1927 Schneider trophy machines; sketch illustrates skin friction coefficients obtained by dividing drag by product of air density, total surface area, and square of wind speed; effects of various modifications for improving drag and pilot's field of view were tried; tests for determining whether resistance of models were equal to sums of resistances of component parts tested separately.

SHAFTS

Clearance. Importance of Length of Guide Bushings (Die Bedeutung der Laenge von Fuehrungen), O. Cosmann. Werkstattstechnik (Berlin), vol. 24, no. 20, Oct. 15, 1930, pp. 556–559, 11 figs. Relation between length of bushing and fit of shaft; proper length of guide bushing permits interchangeability of different fits and increases economy and quality of drives; effect of and remedy for insufficient parallelism of guiding surfaces.

Design. Fatigue of Material and Bending Stresses in Transmission Shafts (Werkstoffermuedung und Biegungsbeanspruchung bei Transmissionswellen), A. Mueller. Maschinenbau (Berlin), vol. 9, no. 19, Oct. 2, 1930, pp. 640–646, 4 figs. Tests for determining permissible bending stresses for shaft operating under different load conditions; effect of surface finish on fatigue failure; effect of Key groove, distance of bearings and weight of pulley; classification of non-uniform power transmission.

Flexible. Flexible Shafts and Their Application (Biegsame Wellen und ihre Werkzeuge), M. Kurrein. Werkstattstechnik (Berlin), vol. 24, no. 19, Oct. 1, 1930, pp. 522–525, 17 figs. Fundamental considerations in design of flexible shafts and their application to hand tools such as grinding wheels, drills and rotating files; graph illustrates output, efficiency, and flexibility of shaft.

SHEET METAL

Welding. Joining Light-Gage Sheet Metal by Arc Welding, T. E. Jerabek. Iron Age, vol. 126, no. 19, Nov. 6, 1930, pp. 1309–1310, 6 figs. Welding by special welding rod to be used manually with carbon electrodes; known as "lightweld" process; may be used for either butt, corner or lap welds, on material of no. 16, 18, 20, and 22 gage, without copper backing to carry away heat; rod is produced in 1/16 in. size and is used with 5/32 in. carbon electrode; table gives current and estimated speeds on butt and corner welds and on lap joints.

SMOKE

Abatement—England. Sheffield Smoke Abatement Problems, F. J. Bailey and E. C. Evans. Gas World (Lond.), vol. 93, no. 2409, Oct. 4, 1930, pp. 302–303 and (discussion), 303. Success has been achieved by total gasification of coal in separate producer plants and firing furnaces with producer gas; through continuous uniform supply of fuel to furnaces, it is possible to obtain control of furnace atmosphere necessary to smokeless operation; coke oven gas firing; survey shows that manufacturers are attempting solution of smoke problem along lines indicated. Abstract of report presented to Sheffield Mfrs.' Smoke Abatement Research Committee.